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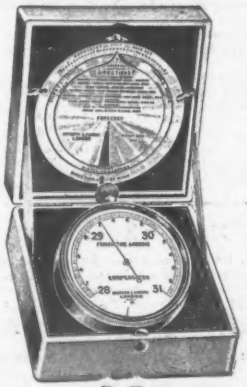

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EXAMINATIONS are held in January; April, July, and October. Exact dates and other particulars are forwarded to candidates whose applications are accepted by the Council.

APPOINTMENTS REGISTER.—A Register of Chemists who are available for appointments is kept at the Office of the Institute. The facilities afforded by this Register are available to Companies and Firms requiring the services of Analytical, Research, and Technological Chemists, and to Universities, Colleges, Technical Schools, etc., requiring Teachers of Chemistry and Technology.

All communications to be addressed to the REGISTRAR, The Institute of Chemistry, 30 Russell Square, London, W.C. 1.

UNIVERSITY OF LONDON.

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A Course of Four Advanced Lectures on "DIVERS MODES DE DYNAMISME DES ÉRUPTIONS VOLCANIQUES, PHÉNOMÈNES DE LATÉRITISATION," by Monsieur A. LACROIX (Membre de l'Institut et Professeur de Minéralogie au Muséum National d'Histoire Naturelle, Paris), at the Imperial College, Royal School of Mines, Prince Consort Road, South Kensington, S.W., at 5 p.m., on June 14, 15, 16, and 17. Chairman: Sir JETHRO TEALL, F.R.S. This Course will be delivered in French with lantern illustrations.

Admission is free to the lectures, which are addressed to Advanced Students of the University and others interested in the various subjects. Syllabus obtainable on application.

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MINISTRY of AGRICULTURE, EGYPT.

The Ministry of Agriculture, Egypt, invites applications for the following appointments on its Agricultural Research Staff at Cairo:—

SENIOR ENTOMOLOGIST.—Candidates should have had experience in original research in Entomology. Initial pay £E600 plus bonus.

JUNIOR ENTOMOLOGIST.—Initial pay £E360 plus bonus.

SENIOR CHEMIST.—Candidates should have had experience in original research in agricultural chemistry. Initial pay £E600 plus bonus.

JUNIOR CHEMIST.—Initial pay, £E360 plus bonus.

Note.—The Egyptian Government bonus referred to consists of an increase of 20% to salaries and in addition a war gratuity of 60% on the salaries so improved, provided that the increase from the war gratuity does not exceed £E192 per annum and that the total increase from both sources of increment does not exceed £E300 per annum. The Pound Egyptian is worth about sixpence more than the Pound Sterling.

Candidates are expected to be in possession of Honours Degrees in Science, and in the case of the chemical appointments, preference will be given to Fellows or Associates of the Institute of Chemistry.

Applications, together with statements of qualifications and references, which will be received up to July 15, 1920, should be endorsed "Research Staff, Egyptian Ministry of Agriculture," and addressed to SIR ARTHUR WEBB, K.C.M.G., Queen Anne's Chambers, Broadway, Westminster, from whom all particulars regarding conditions of service, etc., can be obtained.

MINISTRY of AGRICULTURE, EGYPT.

The Ministry of Agriculture, Egypt, invite applications for the undermentioned appointments on its Agricultural Staff at Cairo. Candidates are expected to be in possession of Honours Degrees in Science.

CHIEF ECONOMIC BOTANIST.—Candidates should have had special experience in cotton breeding. Initial pay £800 plus bonus.

THREE JUNIOR BOTANISTS.—Initial pay £360 plus bonus.

Note.—The Egyptian Government bonus referred to consists of an increase of 20% to pensionable pay, and in addition a war gratuity of 60% on the salaries so improved, provided that the increase from the war gratuity does not exceed £192 per annum and that the total increase from both sources of increment does not exceed £300 per annum. The Pound Egyptian is worth about sixpence more than the Pound Sterling.

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UNIVERSITY OF MANITOBA, WINNIPEG, CANADA.

NEW APPOINTMENTS.

The Board of Governors will proceed shortly to make the following appointments, for which applications are invited:—

PROFESSOR of PHYSIOLOGY, not including Bio-Chemistry or Histology. Initial salary $3800.00.

PROFESSOR of PHILOSOPHY, to be the first appointment in the Department of Philosophy and Psychology recently established. Initial salary $3800.00.

ASSISTANT PROFESSOR of ENGLISH. Initial salary $2500.00.

ASSISTANT PROFESSOR of HISTORY. Initial salary $2500.00; or LECTURER in HISTORY. Initial salary $2000.00.

ASSISTANT PROFESSOR of POLITICAL ECONOMY. Salary $1500.00 to $3000.00, according to experience.

ASSISTANT PROFESSOR of PHYSICS. Initial salary $2500.00; or LECTURER in PHYSICS. Initial salary $2000.00.

ASSISTANT PROFESSOR of CIVIL ENGINEERING, with special qualifications in Municipal Engineering. Initial salary $2500.00.

LECTURER in ZOOLOGY. Initial salary $2000.00.

General information as to the University of Manitoba and its work may be obtained from Professor M. A. PARKER, c/o Messrs. Blackie & Sons, 17 Stanhope Street, Glasgow, or from Professor C. H. O'DONOGHUE, c/o Department of Zoology, King's College, London.

Five printed or typewritten copies of letter of application and testimonials should be in the hands of the SECRETARY of the Board of Governors on or before June 20, 1920.

In the case of the appointment in History one copy of the letter of application and of each testimonial should be sent to Professor CHESTER MARTIN, c/o Rev. C. P. Williams, Henfield, Sussex, and in the case of the appointment in Zoology one copy of the letter of application and of each testimonial to Professor O'DONOGHUE at the address indicated above.

The duties under the new appointments will begin on or about September 1, 1920. Address—

THE SECRETARY,
Board of Governors,
University of Manitoba,
Winnipeg, Canada.

LONDON COUNTY COUNCIL.

There is a vacancy for a WHOLE-TIME TEACHER of MATHEMATICS and PHYSICS at the L.C.C. PADDINGTON TECHNICAL INSTITUTE, SALTRAM CRESCENT, W. Candidates should possess a good honours university degree or its equivalent, but the qualification will not be insisted on in the case of persons otherwise exceptionally qualified.

Commencing salary £225 to £315 a year according to qualifications and experience, rising to £330 a year by yearly increments of £15, thence by yearly increments of £10 to £440 a year.

Preference will be given to candidates who have served, or attempted to serve, with H.M. Forces. Application forms may be obtained from the EDUCATION OFFICER (T.1.), Education Offices, Victoria Embankment, W.C. 2. (Stamped addressed foolscap envelope necessary.) Form must be returned by 11 a.m. on June 14, 1920. Canvassing disqualifies.

JAMES BIRD,
Clerk of the London County Council.

INDIAN GEOLOGICAL SURVEY DEPARTMENT.

The Secretary of State for India proposes to make four appointments to the Indian Geological Survey Department in August this year, if so many qualified candidates are available. Preference will be given to candidates who have served in His Majesty's Forces during the war. Besides a good general education, a sound education in geology is essential: a University degree and a knowledge of French or German will be regarded as important qualifications. Candidates should not be more than 25 years of age, but this rule may be relaxed in exceptional cases. Detailed regulations and forms of application may be obtained from the REVENUE SECRETARY, India Office, London, S.W.1. Applications for appointment must be received not later than August 1, 1920.

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND.

NATIONAL MUSEUM OF SCIENCE AND ART, DUBLIN.

The post of TECHNICAL ASSISTANT in the NATURAL HISTORY SECTION of the above Museum is vacant. Remuneration, including present temporary War Bonus, 69s. a week.

Applications should be submitted not later than June 18, 1920, to the SECRETARY OF THE DEPARTMENT, Upper Merrion Street, Dublin, on a form which may be obtained from the Department.

THURSDAY, JUNE 3, 1920.

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Present State of the Dye Industry.

ON the occasion of the annual general meeting of the British Dyestuffs Corporation held on May 21 Sir Henry Birchenough, who has succeeded Lord Moulton as chairman of the company, emphasised the importance of a great dye-making industry as an instrument of national defence, pointing out that practically the whole of the poison gases used by the German Army in the war were made in the establishments of the German dye manufacturers, as well as large quantities of high explosives and synthetic nitric acid. Chemical warfare, in any future conflict, will no doubt be greatly extended, and its successful prosecution will depend on the equipment, skill, and experience of the dyestuff industry.

Scarcely less important is it in peace, for, as the chairman explained, "the group of textile trades of this country constitute the most striking and important single group of allied industries in the civilised world," and "the magnitude and very existence of a very large part of our export trade in textiles depend absolutely upon there being . . . a sufficient supply of dyestuffs available."

What is being done to establish a great dyestuff industry in this country? There is no doubt that progress has been very considerable, and it is a remarkable fact that the output of dyes in this country (given by the Board of Trade as 25,000 tons annually) exceeds the total consumption before the war.

The range and variety of these dyes are, however, admittedly limited, and, indeed, Mr. A. Hoegger, chairman of the British Cotton and Wool Dyers' Association, at the annual meeting held on the same day as the above, stated that, had it not been for the importation of certain Swiss dyes during the war, and the arrival recently of certain "reparation" colours from Germany, some of the branches of the association would have been seriously embarrassed.

There are two rather important points that require comment here. Sir Henry Birchenough stated that "an unprecedented demand for finished dyestuffs prevents the creation of stocks, and thereby places difficulties in the way of the maintenance of uniformity in our products." This is no doubt a reply to complaints as to lack of uniformity in the dyes supplied. There are two ways in which this can occur, viz. as regards shade and as regards strength.

If the preparation of a dye has been properly worked out in the laboratory and in the small-scale plant (such as exists at Huddersfield), the large-scale manufacture should present few difficulties. Granted that the first few batches may leave something to be desired, succeeding batches made under careful scientific control should certainly be very close to the standard required, and the stock necessary to allow this difference to be adjusted should not be more than three or four batches—say a ton at the utmost. With regard to the strength of the dye sent out, Mr. Hoegger states that a great proportion of the 25,000 tons is not so highly concentrated as were pre-war German colours. Almost every dye coming from the drying chamber is stronger than the standard, even taking as standard the German pre-war dye, and it is exceedingly bad policy to reduce the strength below it. This cannot be other than deliberate, and is very objectionable, as the quality of the dye is thereby depreciated in the mind of the user, and in this connection there is evidence that the Canadians are not altogether satisfied with the quality of the dyes imported from this country.

"Why," it will be asked, "cannot we make here those dyes which are being imported from Switzerland and vicariously obtained from Germany?" The answer to this question is: First, lack of plant; and secondly, lack of raw material. The former is referred to by Sir Henry Birchenough, who points out the great delay in delivery of plant owing largely to the moulders' strike. The provision of the multitudinous variety of pans, autoclaves, and acid-resisting vessels required by the industry is proceeding only slowly, and especially is this true of enamelled appliances. Even

the refuse of the engineering shops, iron borings, was no longer forthcoming during this strike, with the consequence that the manufacture of aniline was seriously retarded.

How the lack of special plant prevents the supply of certain dyes is well illustrated in the case of rhodamine. The intermediate products required for this are diethyl-*m*-aminophenol and phthalic anhydride. The former is prepared from diethylaniline, for which, unlike dimethylaniline, enamelled autoclaves are required, and the latter requires special plant for the oxidation of naphthalene by means of a mercury catalyst. Although indigotin is no longer prepared by the Badische process from phthalic anhydride, the importance of this intermediate is still great, and as the English rights of the new process of the American Bureau of Chemistry, oxidation in the vapour phase in the presence of a catalyst, have already been purchased, it may be expected that this product will soon be manufactured here at a comparatively very low cost. It will readily be understood that, in view of the necessity of installing two special plants for the intermediates required, manufacturers both in England and in America have not succeeded in placing anything but insignificant amounts on the market.

With regard to the provision of other intermediate products there is still much to do, and at the present time the demands for such elementary materials as aniline and β-naphthol greatly exceed the supply. The latter is required for the manufacture of such important intermediates as γ acid and J acid, and when it is considered that β-naphthol was not made in England at the outbreak of war, it will be realised that it is necessarily a slow operation to produce these acids, involving as it does three distinct plants.

It must not, however, be concluded that British manufacturers have confined themselves to the dyes which are made with least trouble. The Solway Dyes Co., in particular, was first in the field with a range of important vat dyes, and this firm, as well as the British Dyestuffs Corporation and others, has placed a useful series of fast dyes on the market. The erection of a large works in Trafford Park, Manchester, by the British Alizarine Co. must lead to a greatly increased output of alizarine dyes, and there is little doubt that slow but steady progress is being made. The time should not be far distant when British manufacturers will not only supply all requirements for the home market, but also make their products known all over the world.

Poetry and Medicine.

Philosophies. By Sir Ronald Ross. Pp. viii + 56. (London: John Murray, 1911.) Price 2*s*. net.

Psychologies. 69 pp. (Same author and publisher, 1919.) Price 2*s*. 6*d*. net.

THESE slender volumes, by Sir Ronald Ross, deserve to be read with sympathetic interest for more reasons than one—not least because they reflect the mind, and throw light on the spirit which has guided the work, of a man whose services to medical science are great indeed. In the long history of medicine and of poetry we can call to mind many a physician who has been also a poet. No great physician has ever likewise been that rare and wonderful thing, a great poet, for the toilsome life of the one is not to be combined with the fine freedom, the careless rapture of the other. But there is a certain excellence which, though it fall far short of supreme perfection, is still a very fine and splendid thing, and to such excellence I think Sir Ronald Ross has certainly attained.

The poet-physicians whose names first cross our minds are men attached by but a slender link, a titular claim, to the profession of medicine; nevertheless, the profession is proud to have had enrolled among its brotherhood Dr. Oliver Goldsmith and the great apothecary whom a foolish critic bade "go back to his gallipots." In Goldsmith's footsteps follows Crabbe, bringing us his "Village" and his "Parish Register," bidding us, in lines scarcely less finished and less memorable than Goldsmith's own, "Behold the Cot, where thrives th' industrious swain, Source of his pride, his pleasure and his gain . . . "; or, moving quickly to sadder themes, "When the sad tenant weeps from door to door, And begs a poor protection from the poor." A little shred of Keats' great mantle (and more perhaps of Shelley's) fell upon that fine poet, and not unlearned physician, Thomas Lovell Beddoes, the friend of Blumenbach and Schoenlien and Frey—Beddoes of "The Bride's Tragedy." "Death is more a jest than life; you see Contempt grows quick from familiarity. I owe this wisdom to Anatomy"—so he wrote from Göttingen while he was a student of medicine there; and the same contemptuous familiarity lasted him to the end, when he used his physiological knowledge of a new and terrible drug—curare—to "creep into his worm-hole," to introduce him to that grim pageantry of Death which his verse had described with a fearful reality. "The power of the man," said Browning, "was incontestable and immense"; and in his happy hours he had written very lovely and most

musical things. The song about "How many times do I love thee, dear?" is not to be forgotten; nor do those who have read it ever forget his exquisite "Dream-pedlary"—"If there were dreams to sell, What would you buy?"

To another order of poets belongs a little cluster of seventeenth- and eighteenth-century physicians, Garth and Akenside and John Armstrong and Erasmus Darwin. They are of that quiet, humourless, didactic school for which we have lost our relish, and for which Dr. Johnson (apart from his bitter quarrel with the last, the Lichfield, physician) had all too kindly a word.

We no longer read Garth's "Dispensary," any more than we read his once celebrated Harveian oration, although the poem was "on the side of charity against the intrigues of interest, and of regular learning against licentious usurpation of medical authority." In other words, it was a pedantic account of a quarrel between the College of Physicians and the Society of Apothecaries. "It appears," says Johnson, "to want something of poetical ardour, and something of general delectation"—a fair and honest verdict, which we might illustrate and support by any stray line or two—by those, for instance, where the poet describes "Why bilious juice a golden light puts on, And floods of chyle in silver currents run; How the dim speck of entity began T' expand its recent form and stretch to Man."

Akenside was a much better poet, and seems also to have been a more learned physician. His "Discourse on the Dysentery" "entitled him to the same height of place among the scholars as he possessed before among the wits"; and "The Pleasures of the Imagination" is still worth our while to read, if it be only for some few noble and exalted passages. We may lay it down, as Pope did, with the feeling that "this is no every-day writer!" There runs through it a sincere and almost prophetic belief in the value of research and the progress of science—in "Science herself . . . the substitute Of God's own wisdom in this toilsome world, The Providence of Man." Of Armstrong, who contributed some "medical stanzas" to "The Castle of Indolence," and wrote his "Art of Pursuing Health" in indolent Thomsonian verse, we need scarcely speak. He was admired in an age by no means devoid of polished culture, but content to read and even eager to buy such dreary, sluggish blank verse as "Hail sacred flood, May still thy hospitable swains be blessed In rural innocence," and so on, to the end of the quarto volume.

Erasmus Darwin's "Botanic Garden" and "Loves of the Plants" have merits of their own, and an historic interest not to be gainsaid; but in his poetry there is a *je ne sais quoi qui manque*, though it was wont at one time to be spoken of in the same breath with Cowper's "Task," and even with "Paradise Lost." They are the most didactic of didactic poems. The good doctor revels in facts, in the communication of knowledge, or rather of information. The world is ransacked for objects of wonder and contemplation. As his biographer, Miss Anna Seward, tells us, "the operations of the weather-glass and air-pump are described with philosophic accuracy and poetic elegance." There is "a grand picture, though of somewhat forced introduction," of the crocodile bursting from its egg on the banks of the Nile. The embryo plant is introduced to us by "Lo! on each seed, within the tender rind, Life's golden threads in endless circles wind, etc." We turn the page and come to "where the humming-bird, in Chili's bowers, On fluttering pinions robs the pendent flowers; Seeks where fine pores their dulcet balms distil, And sucks the treasures with proboscis bill." The sinuous track of the serpent glides, with no apparent reluctance, into "So, with strong arm, immortal Brindley leads His long canals, and parts the velvet meads." Yet the simple mind of this old poet-physician, utterly destitute of humour or romance, had (as we all know) a vast deal of wisdom commingled with its simplicity.

In our own day, or within our immediate recollection, there have been many members of the medical profession who could put on their singing robes once in a way, and write creditable verse or sing still better convivial songs. There was a whole brotherhood of them in Edinburgh a generation ago, with such men as Douglas Maclagan and Andrew Wood and James Sidey and J. D. Gillespie and John Smith, who touched art with the humour, and now and then with the pathos, of their post-prandial lyrics. But we had better not pause over the "Nugæ Canoræ Medicæ," or "Mistura Curiosa," or "Alter Ejusdem"—certainly not over that triumphant outburst of "old Sidey's" hilarious conviviality, "The Cat's got the measles and it's deid, puir thing!" scarcely even over the soft lowland accent and the tender lilt of "The burnie that wins to the sea"—"Up near the scaur where the hoodie-craw bides, Up near the foot of the keelie-craig hie, Deep in the hidie-heugh, riv'd frae its sides, Rises the burnie that wins to the sea." In the same town of Edinburgh we had very lately the Cornishman, Ricardo Stephens, another poet-physician, writer of strange ballads and dreamer of rich, imaginative dreams. It was he who

wrote "The Piper of Hell"—"O have ye heard of Angus Blair, Who lived long since in black Auchmair?" and a more terrible and cruel ballad still—"Who hath not met Witch Margaret? Red gold her rippling hair. . . . Come up and you shall see her yet, Before she groweth still; Before her cloak of flame and smoke The winter air shall fill; For they must burn Witch Margaret Upon the Castle Hill."

Together with these Edinburgh worthies we may say a passing word of two Dublin physicians of the last generation, George Sigerson and John Todhunter. They were both of them fervid writers of Celtic poetry, and have a notable place in their country's undoubted literary renaissance. Irish patriotism inspired them both, in a way that we little understand—as when Todhunter cries out "O thou Swan among the nations, enchanted long, so long That the story of thy glory is a half-forgotten song." He was a powerful and influential singer, a true Irish Tyrtæus; for it was he who wrote "There's a spirit in the air, Says the Shan Van Vocht"; just as another learned brother-scholar and fellow of Trinity College, Dublin (not a physician, however), boldly sang: "Who fears to speak of '98?" and sang it to only too receptive ears.

But I have gone farther afield than I ever meant to go, and I have left myself all too little room to write of Sir Ronald Ross, the last of our poet-physicians. Most of his poetry was written in India, in Madras or Burma or the Andamans, while he was engrossed in the study of the pathology of malaria, and during earlier years when he began to think and dream over the eternal problems of the East. Sir Ronald's love and reverence for science, and his admiration for those who have shown and followed the way of discovery, are deeper because far more experienced than Akenside's: "Tho' we may never reach the peak, God gave this great commandment, Seek."

It is not the wealth and splendour of the East that touch his imagination; but, looking with the physician's charitable eyes, he broods over the decadence, the misery, the widespread sickness of its people: "The leprous beggars totter trembling past, The baser sultans sleep." A famine-stricken girl is suckling her three-year-old: "'I am too poor,' she said, 'To feed him otherwise,' and with a kiss Fell back and died." It is all a gloomy picture. But if its blackness be somewhat overdrawn (and I hope and think it is) its pessimism is inspired and redeemed by charity and pity, by resolution to understand, and by ambition to relieve. Sir Ronald's second volume, though tragic enough, is in a happier strain.

Only a few days ago, lecturing to my class of some eighty young men and women newly entered a week before upon their medical course, I tried to tell them what the Protozoa meant to our fathers, and what (thanks to Pasteur and Grassi and Manson and Bruce and Ross and many another) they have come to mean to us. In my student-days, an Amœba, a bell or slipper animalcule, a little ooze from the Atlantic, a few pretty radiolarian or foraminiferal shells, gave us our outline-concept of the Protozoa. To-day a new world is opened, in which we hear of tiny things with strange life-histories, of momentous chains of cause and consequence wherein rat and louse and gadfly and mosquito play their insidious part, bringing fever to the swamp and murrain to the plain; we are told at last of mysterious maladies explained, of epidemics held at bay, of territories and peoples emancipated from disease. And then, as an example of the spirit of the scientific physician, of aims conceived, of dreams come true, I ventured to read them a couple of Ronald Ross's early verses, written before he and his fellow-workers had brought their hopes to fruition:—

In this, O Nature, yield, I pray, to me.
I pace and pace, and think and think, and take
The fever'd hands, and note down all I see,
That some dim, distant light may haply break.

The painful faces ask, Can we not cure?
We answer, No, not yet; we seek the laws.
O God, reveal thro' all this thing obscure
The unseen, small, but million-murdering cause.

My students listened and went quietly away, and I could see by their faces that they had heard the words of the poet and the physician as though he were speaking straight to them.

D'ARCY W. THOMPSON.

Movements of Plants.

Transactions of the Bose Research Institute, Calcutta. Vol. ii., *Life Movements in Plants.* By Sir Jagadis Chunder Bose. Pp. v+xiv+253–597. (Calcutta: The Bose Research Institute, 1919.) Price 10*s.* 6*d.*

IN this the second volume of the Transactions of the Bose Institute, Sir Jagadis Bose continues to pour out his almost overwhelming wealth of observations. The first chapter of the volume deals with a piece of apparatus to be used with

the "high magnification crescograph" which magnifies the rate of growth up to ten million times. As, even with much lower magnifications, the spot of light or point of the lever would soon move off the scale or recording surface, the author has devised a method of balance different from the optical method originally used. In this new method the plant-holder is connected with a series of gear-wheels driven by a falling weight and controlled by a fan governor. By this means the plant-holder can be made to fall at various rates, and thus the growth of the plant is compensated, and we have what is termed the "balanced crescograph." When the rate of growth is exactly balanced the record will show a horizontal line, and any increase or decrease in the rate will be indicated by a rise or fall in the curve. By this means it is claimed that a change in the rate of growth of only 1 part in 27,000 can be detected. The method is one of great delicacy, it is clear, but, in view of the fact that the control of the speed of movement is in part frictional resistance, and also of the effect of grit and of inequality in the cutting of the gear-wheels, one would have liked to see the inclusion of a record which would demonstrate that a speed of 0·5 μ per sec. was kept constant to 1 part in 25,000 for many hours.

The volume contains thirty chapters on various plant reactions which exhibit themselves either by movements or by electrical response. Of these perhaps the most striking is the interesting contribution which the author makes to the problem of the mechanism of geotropic response. In the statolith theory of geotropism one link in the chain of reactions which bring about geotropic curvature is the shifting, under the influence of gravity, of comparatively large starch grains in a tissue such as the endodermis of the stem. This theory is upheld by the author as a result of the exploration of the plant by means of his "electric probe." The probe consists of a fine glass tube (0·15 mm. diam.) with a still finer platinum wire fused into, and projecting just beyond, it. The probe can be pushed into the tissues of a stem, while the other end of the platinum wire is connected with one terminal of a galvanometer, the other terminal being connected with some other part of the plant, *e.g.* a leaf, which is always kept horizontal. The probe is first placed on the surface of the organ, and the deflection is observed when the stem is placed horizontal; the stem is then returned to the vertical position, the probe advanced a little into the tissues, the stem again placed horizontal and the deflection observed. It is found that as the probe penetrates the deflection rises to a maximum and then falls to a minimum at about the centre of the stem. *The point of the probe in the position of maximum deflection is found to lie in the endodermis.* If the probe is carried forward towards the other side of the stem, a new maximum is found when the point reaches the endodermal layer on the other side, *but the deflection is in the opposite direction.*

This observation does not, of course, prove that the endodermis is the geo-perceptive layer, but it provides circumstantial evidence in favour of that view, since it demonstrates that the endodermis is the only tissue exhibiting a marked electrical reaction to geotropic stimulus. In one case where the angle of the stem was gradually increased there was no deflection until a critical angle of about 33° was reached, but above this there was a marked electrical response. There appears to be some frictional resistance to the displacement of the starch grains, which is not overcome until the critical angle is passed. By comparing the electrical response (which can, of course, be observed without the use of the "probe") of organs placed at angles of 90° and 45°, respectively, with the vertical, evidence is obtained in support of the view that the geotropic response is proportional to the sine of the angle.

The marked effect of temperature on the degree of geotropic response, which leads to decided diurnal movements of many stems, is a thesis which is further elaborated in this volume, as is also the difference between "direct" and "indirect" stimulation. The volume is filled with numerous and often stimulating observations carried out with the author's well-known mastery of the technique of experimentation. One must be grateful for the new weapons which he has forged and for the new fields of work which he has opened up, but, like Sir J. C. Bose's previous volumes, the present one is often sadly lacking on the plant-physiological side. The work done is never properly related to that of previous investigators, the author confining himself to the quotation of text-books, which are often of no very recent date; in dealing with phototropism the work even of Blaauw is not mentioned. Again, Sir J. C. Bose seems so anxious to add to his collection of "plant-records" that he passes rapidly from observation to observation and from problem to problem, shedding on the way a beam of light into some of the dark places of plant physiology, but never satisfying us with a problem fully envisaged and worked out.

V. H. B.

Applications of Electricity.

(1) *Telephonic Transmission: Theoretical and Applied.* By J. G. Hill. (Manuals of Telegraph and Telephone Engineering.) Pp. xvi+398. (London: Longmans, Green, and Co., 1920.) Price 21*s.* net.

(2) *The Principles of Electrical Engineering and their Application.* By G. Kapp. Vol. ii., *Application.* Pp. viii+388. (London: Edward Arnold, 1919.) Price 18*s.* net.

(1) THE applications of electricity in the telegraph and telephone services are now so numerous and so highly specialised that no one can claim to have an expert knowledge of every branch. It has been decided, therefore, to produce a series of handbooks which will cover the whole of the ground involved. The editor of the series is Sir William Slingo, late engineer-in-chief of the Post Office, and most of the authors are on the staff of the Engineering Department. Judging from the present volume and from the names of the authors preparing the other volumes of the series, we shall soon have a very complete and thorough account of English telegraphic and telephonic practice.

This book is written for experts engaged in the practical applications of telephony, and must be judged from this point of view. It is now ancient history how the early telephonists did their best to diminish the capacity and resistance of their lines with the object of securing good communication. In 1887 Oliver Heaviside pointed out that this rule was quite fallacious. The two qualities of the line which it is necessary to study are the attenuation of the signals and the velocity with which they are propagated. Heaviside stated this clearly and showed that his "distortionless" circuit gave the complete solution of the problem. In 1900 Prof. Pupin showed how a distortionless circuit might be secured very approximately by putting inductance coils at certain intervals in the line. When the distance between the coils is small there will be little reflection of the waves by them, and in this case the practical working will be satisfactory.

There are many engineers employed in telephone work who have great difficulty in following the advanced mathematical reasoning of Heaviside and Pupin, and yet they have to evaluate their complicated formulæ in everyday work. For their benefit the author introduces additional chapters describing the transmission of direct currents along a leaky line and getting the equivalent circuits. This should give those engineers confidence to attack the complete mathematical problem which is given in appendices.

The symbols and general arrangement of the formulæ are mostly those used by Kennelly and Fleming, whose work is much appreciated by the British Post Office. To the general man of science most of the book will appear to be endless variations of complicated formulæ, involving complex variables, deduced from comparatively simple differential equations. But a study of the book will show him how laborious it is to get numerical solutions, and how ingenious are some of the methods employed to get the constants of the line. The chapter on "the human voice in telephony" is illustrated by excellent oscillograms of the alternating currents produced by certain words. There is also a chapter on the thermionic valve as a telephonic relay which is of great interest. Very instructive characteristic curves of the valve are shown. A curve is also given which proves the enormous variation of magnification with input. The use of these telephonic relays is most promising, and great developments may shortly take place.

The book will be of great value to the telephonic engineers for whom it is written. We were much interested in the electrical constants of many of the cables used in practice which have been calculated by the author. They prove conclusively the great value of advanced mathematical theory in telegraphy and telephony.

(2) As a pioneer of the applications of electricity Prof. Kapp has had the pleasure of seeing many of his theorems become incorporated in the routine teaching of technical colleges and many of his methods widely adopted in everyday practice. The technical student, therefore, will find much that is familiar in this volume; but he will also find that the proofs given in many cases have been appreciably simplified. The author invariably keeps practical considerations in the foreground and rarely, if ever, digresses on points of abstruse theory. In discussing the running of machines he makes little endeavour to elaborate the theory, but gives, in most cases, a clear first approximate solution. The book, therefore, will be welcomed by the engineer and the student. The former will gain a clearer view of the principles on which his machines work, and the latter will find that many long mathematical solutions can be much shortened by elementary graphical methods.

In the earlier chapters direct-current machinery is described. The treatment of the critical speed of turbo-dynamos is very neat, and the results agree with experiment. Little space is given to losses which are relatively unimportant—bearing friction, for instance. The methods of coupling dynamos for parallel running are fully described.

A clear description of the Thury system of direct-current high-tension transmission is given. There seems to be little chance, however, of this system being adopted on a large scale in this country. Chap. v. describes the uses of a storage battery in connection with a dynamo. Brief descriptions of the various types of booster used in this connection are given and will be helpful to the student.

In chap. vii. a brief reference is made to Fourier's theorem. The coefficients are obtained by drawing the graphs of curves the equations of which are of the form

$$y = f(x) \cos (2\pi nx/\lambda),$$

and then getting their area by the planimeter. Although theoretically correct, we think that the method would prove laborious in practice. We think also that the error for high harmonics would probably be large, as the planimeter reading gives the difference between many areas.

The author suggests that large choking coils should be constructed in the form of a toroid, the diameter of the circular cross-section of which equals 0·311D, where D is the mean diameter of the toroid. This is Maxwell's solution for the most economical coil; and the author has found practically that the expression $9{\cdot}35n^2D$ gives its inductance, where n is the number of turns. This is in good agreement with Maxwell's formula, $3\pi n^2D$—*i.e.* $9{\cdot}43n^2D$. It has to be remembered, however, that Maxwell's formula is only a rough approximation. If we use Rayleigh's formula we get $9{\cdot}69n^2D$ for the inductance. The 4 per cent. difference between theory and experiment is probably due to the assumption that the current is uniform all over the cross-section of the toroid. If we use Rayleigh's formula it will be found that we get very appreciably different dimensions for the most economical choking coil.

The discussions of parallel running, transformers, converters, and induction and commutator motors are all instructive and suggestive. The last chapter, on phase advancers, is a strong and convincing plea for their more general adoption in practice. Considerable economies can be effected by their use.

A. RUSSELL.

British Iron Ores.

The Iron Ores of Scotland. By M. Macgregor, Dr. G. W. Lee, and G. V. Wilson. With contributions by T. Robertson and J. S. Flett. (Memoirs of the Geological Survey, Scotland: Special Reports on the Mineral Resources of Great Britain: Vol. xi. *Iron Ores (continued).*) Pp. vii + 240. (Edinburgh: H.M.S.O.; Southampton: Ordnance Survey Office.) Price 10*s.* net.

THE present volume forms a continuation of the important series of memoirs on the iron ores of Great Britain which the Geological Survey has been issuing for some time past. Unlike some of the previous ones, the subject here discussed affords little scope for original geological investigations, the principal deposits of iron ore being very well known and having often been described. As is, however, very truly remarked by Sir Aubrey Strahan, the information concerning them is scattered throughout a large number of publications, and it is a great advantage to the student of the subject to have it all brought together in one volume. The authors have done their work carefully and painstakingly, and the result of their labours has been to render available a very complete and minutely accurate record of the known Scottish iron-ore deposits.

The book is divided into seven chapters. The first gives an introductory and historical account of the subject, containing much interesting matter; attention should, however, be directed to a mistake as to the nature of the old Catalan furnace. The author writes: "These furnaces were of the Catalan type, . . . and castings were apparently made direct from the furnace itself." These two statements are incompatible, for the essential feature of the Catalan process was that it produced malleable iron, and not cast iron, direct from the ore.

The next four chapters are devoted to the bedded iron ores of Carboniferous age, these being subdivided mainly according to their geographical distribution. In a sixth chapter the bedded Raasay ironstone of Jurassic age is described, and in the last chapter a number of minor occurrences, which are grouped together under the heading "Hæmatite in Veins and Beds"—a somewhat infelicitous title, seeing that true hæmatite is conspicuous by its absence.

As in the previous volumes of the series, the least satisfactory portion of the present one is that relating to the estimated tonnage of ore reserves. It ought to be made thoroughly clear that the tonnage of ore as estimated by a geologist represents a quantity many times greater than that which the miner can hope to recover in actual practice. The iron industry of Scotland requires some 2½ million tons of ore annually, about one-fifth of which is obtained from native Scottish deposits, and it is poor consolation to the Scottish ironmaster, who for a good many years past has

been in the greatest difficulty to know whence to draw his ore supplies, to be informed officially that the probable reserves are more than 94 million and the possible reserves more than 435 million tons, he meanwhile knowing but too well that only a very small fraction of even the smaller figure is ever likely to find its way to his furnaces. H. LOUIS.

Our Bookshelf.

Practical Pharmacology: For the Use of Students of Medicine. By Prof. W. E. Dixon. Pp. viii + 88. (Cambridge: At the University Press, 1920.) Price 7*s.* 6*d.* net.

WE welcome the appearance of Prof. Dixon's manual; it is certainly the most practical and useful guide to students of experimental pharmacology which we know. The experiments are extremely well chosen to illustrate the underlying principles of therapeutics, and the text, with its illustrations and tables, is so clear and logical that a student can at no time be in doubt as to the methods for performing the experiments, or fail to appreciate their bearing on the practical application of the drugs in disease.

The experiments, some seventy-eight in number, are classified to explain the action of drugs on the various systems of the body, and while use is made mainly of the pithed frog, suitable experiments with mammalian tissues are introduced. Experiments with decerebrated mammals are not described, the author considering that their use in large classes is impracticable and that they may be replaced by suitable demonstrations under Certificate C. A chapter is devoted to a description of the essential physical properties of important drugs, and there is appended a useful table of the doses required to produce typical pharmacological effects in animals.

We have no hesitation in recommending this book as an excellent guide to the study of practical pharmacology. It is one which will be extremely useful to students of medicine, whether they are receiving experimental tuition in the laboratory or not, and it will also be read with much profit by medical men who have not had the advantages of a practical training in the action of drugs.

The Teaching of Science in the Elementary School. By Gilbert H. Trafton. (Riverside Text-books in Education.) Pp. x + 293. (New York: Houghton Mifflin Co.; London: Constable and Co., Ltd., 1918.) Price 6*s.* 6*d.* net.

IN a brief introduction Prof. Cubberley states that the author's aim was "to construct a simple and helpful volume for the teacher who is called upon to teach elementary science lessons, and yet has neither scientific training nor apparatus for the work." The statement prepares the reader for the limitations of the book. Mr. Trafton's scheme includes practically no chemistry, and the physics is both exiguous and scrappy; by far the greatest part consists of simple observational work upon plants and animals. Within these limitations, however, there is much that is both attractive and useful, and the limitations themselves correspond to those of most rural elementary schools in this country.

Mr. Trafton classifies his subject-matter under the headings of biological, agricultural, physical, and hygienic science, and rightly insists that, however rudimentary the work along these lines may be, it should be done in the genuine scientific spirit. In his introductory chapters he gives a good deal of sound and practical advice with regard to the choice of subject-matter and the methods of teaching, and the bulk of the book consists of sections in which typical parts of the curriculum he recommends are worked out in detail. The curriculum is, of course, chosen with reference to American conditions, but the English teacher should be able to profit by Mr. Trafton's suggestions. There is a carefully compiled bibliography, covering practically the whole field treated in the book, but consisting entirely of American titles.

Peoples of the Philippines. By Prof. A. L. Kroeber. (American Museum of Natural History: Handbook Series No. 8.) Pp. 224. (New York: American Museum of Natural History, 1919.)

THE interest of the Philippine Islands to the ethnographer lies in the fact that they are the largest of the possessions of the United States, and the only one of importance in the Eastern hemisphere; that they form a considerable and growing nationality; and that they display in an unusually complete manner the stratification of races and cultures. Three types of race can be identified in the present population, and these may be arranged in the probable order of their arrival—the Negritos of the interior, a short, black people with an elementary type of religion and culture; the Indonesians, of the Mongoloid family, but presenting fewer specific Mongoloid features than the third race, the Malayans, occupying the coastal areas. As regards culture, the remarkable fact is the predominance of Indian influence as compared with that of China, which provided little more than certain manufactured products. India did not furnish the Filipinos with a definitely crystallised religious cult, or, if so, this cult had already disappeared before the Europeans appeared on the scene. But there came from the Indian races, probably by Malay intervention, a mass of religious practices, ideas, and names, a considerable body of Sanskrit words, a system of writing, the art of metallurgy, a vast amount of mechanical and industrial knowledge, and unquestionably a much higher degree of civilisation than their predecessors had acquired. These facts are clearly brought out in the present handbook, which provides in small space much information, and is furnished with good maps and illustrations.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Flight of Flying-fish.

IT is disputed whether the flight of flying-fish is a genuine flight or simply a leap and a glide. The question is referred to in the section devoted to flying-fish in the Natural History Museum, South Kensington. Recently I have had ample opportunity to study these fish in the tropical waters of the Atlantic and Pacific Oceans.

The observations which I have made and the conclusions at which I have arrived are corroborated by the officers of the R.M.S. *Victoria*. Many of these gentlemen were surprised to hear that there was any doubt on the matter. That the flight is a genuine one is proved by the following facts:—

(1) During flight these fish are able to turn at right angles, and even at a very acute angle. More than once I have seen a fish turn with great rapidity at an acute angle and come back in a direction opposite to the direction in which it set out. A mere glide will not enable any animal to do this.

(2) Standing at the bow of the ship directly above some flying-fish which were in a hurry to get out of the way, I saw the wings flap as distinctly as the wings of any frightened bird.

(3) Some of these fish fly for a distance of from 150 to 200 yards without rising more than a couple of feet above the surface. They rise over the crests of the waves and sink into the hollows. They could not do this by a mere leap and a glide.

(4) Besides flying low over the surface of the waters, they are also able to rise to a considerable height, and not infrequently come on board large steamers. When they fall on deck their wings can be seen, as well as heard, flapping. It is true that they are unable to rise from the deck, but the same is true of many sea-birds.

(5) When in full flight the outlines of the wings are indistinct and blurred in contrast with the clear outline of the body. This can only be due to the very rapid movement, as in the case of hovering flies and humming-birds.

J. MCNAMARA.

3 Holland Road, Kensington, W.

An Experiment on the Spectrum.

IN school and college courses little experimental work is done on the infra-red and ultra-violet parts of the spectrum. The student is, of course, told about these regions, and how they can be detected respectively by the heating and actinic properties of their rays. But he is not allowed to investigate these rays himself, nor are their properties demonstrated before him. This is on account of the elaborate nature of the apparatus necessary; the infra-red region requires a thermopile or bolometer, together with an expensive galvanometer, and the ultra-violet requires photographic methods and a spectrograph. So much apparatus cannot be afforded for one experiment, and besides is apt to distract the student's attention from the simple nature of the facts involved.

If, however, a very intense spectrum is used, the infra-red can be mapped roughly with an ordinary thermometer, and the ultra-violet with a photographic exposure-meter. Neither galvanometer nor spectrograph is necessary. The thermometer I have used is a Fahrenheit one, range 0° to 220°, the bulb of which is blackened by dipping it into lamp-black shaken up with methylated spirits; the bulb is 5 mm. in diameter. The exposure-meter is the Imperial exposure-meter for dull light and interiors, which costs 1*s.* 6*d.* together with a refill. In this instrument a piece of sensitive paper is exposed to the light, and the time noted that it takes to darken to a standard tint. The sensitive paper supplied darkens two or three times as fast as ordinary P.O.P. As source of light I have used a little 5-ampere arc lamp, which is run off the lighting circuit through a rheostat. The anode is horizontal and the cathode vertical; they are both enclosed in a glass cylinder which restricts the supply of oxygen, and so lengthens the life of the carbons. Lamps of this pattern burn very steadily, and have come into wide use during the past ten years. It is because so many laboratories have these lamps that I describe this experiment here. An arc of this pattern is absolutely necessary; a pointolite or half-watt lamp is of no use for the purpose.

As lens I have used a spectacle lens of 25 cm. focal length, and as prism a single equilateral dense flint 1¼ in. high. The spectrum and arc are equidistant from the lens. As slit I have used the crater of the arc, which measures about 3 mm. in diameter, since the carbons in this type of lamp are only 5 mm. thick. If the rays of light from the anode fell squarely on the lens we should have a point image of a point source, and the spectrum would be only 3 mm. high, but by setting the lens obliquely, rotating it through 30°, an astigmatic line image is formed, and we get a reasonably sharp spectrum 12 mm. high. Stray light is excluded by enclosing the arc in a box.

The following table gives a set of results taken in somewhat less than an hour:

Scale cm.	Colour	Rise of temperature °F.	Photographic action
7·0	—	0·0	—
7·5	—	0·8	—
8·0	—	3·4	—
8·5	—	5·4	—
9·0	Infra-red	3·4	—
9·5	Red	2·0	—
10·0	Yellow	0·5	0·5
10·5	Green	—	2·7
11·0	Blue	—	1·5
11·5	Violet	—	2·4
12·0	End of visible	—	5·0
12·5	Ultra-violet	—	5·0
13·0	—	—	0·57

The ends of the visible spectrum were at 9·2 and 12 cm. The first column gives the readings on a centimetre scale placed along the spectrum, the second column the name of the colour, the third the rise of temperature experienced by the thermometer in three minutes, and the fourth the reciprocal of the time in minutes taken by the paper to darken to the standard tint. In the case of the last two readings the exposure-meter was illuminated by stray light. It is possible to go further into the ultra-violet if a crown glass prism is used. The infra-red measured goes to 2·2 μ or thereabouts. If a piece of P.O.P. is exposed to the spectrum for a couple of minutes, it shows bands—one from 10–11 cm., another from 11·3–11·7 cm., and a third from 11·8–12·7 cm., the positions all being measured on the centimetre scale above referred to.

It is interesting to remember that when Sir William Herschel discovered the heat spectrum in 1800 he used thermometers. The source of light was the sun, and the arrangement was similar to Newton's original one—the prism was placed close up to a slit at a window, no lenses were used, and the spectrum

was consequently very impure. Three thermometers were placed apparently at a distance of about 4 ft. or 5 ft. from the prism—one in the spectrum, and the other two in the shadow beside it—and the difference of temperature produced by the rays was noted. The bulbs of the thermometers were blackened; one of them measured ½ in. in diameter, but the others were smaller. One and a half inches beyond the red there was a rise of 3½° in 10 min., 1 in. beyond the red 5¼° in 13 min., and ½ in. beyond the red 6½° in 10 min. In the violet there was a rise of 1° in 15 min. The spectrum was about 3 in. long, and the heat rays could be detected a distance of 2½ in. into the infra-red.

R. A. HOUSTOUN.

University of Glasgow, May 19.

Anti-Gas Fans.

IN a note in NATURE for May 13 you intimated that my "allegations" concerning the treatment of my anti-gas fans by the War Office and the suffering and loss of life thereby entailed could not be accepted without question, and you called upon the "well-accredited men of science," who, you say, largely staffed the Anti-Gas Service, to make a "plain statement of the facts." I waited to see if such a statement would be forthcoming, though I judged it scarcely likely; and now, since it has not appeared, I ask you, in fairness, to grant me space for a few remarks on your note.

You suggest that such an indictment as I have brought against the War Office, reinforced as it is with their own letters, reports, and pamphlets, can be refuted by the bare word of certain "well-accredited men of science." I pass over the implied slur on myself of being less well-accredited than they, my word of smaller value than theirs. No unprejudiced person who has read that indictment and that evidence with any care will agree with you that they can be thus easily disposed of.

In my dealings with the War Office I had to do with innumerable officials, some of them men of science, most not. From their behaviour I judged the larger number (and the exceptions were not, I regret to say, men of science) to be mere puppets, acting under the direction of some leading spirits behind. Who those leading spirits were I had no means of knowing; I was carefully kept in the dark. You, sir, intimate that they were "well-accredited men of science." If this was indeed so, then surely you will agree with me that, for the sake of science even more than in the interests of the nation at large, it is essential that this matter should not be hushed up, but that a public inquiry should be instituted. I am not only willing, but also most anxious to submit my case to some impartial tribunal. Will the men of science whom you have asked to speak, but who do not answer, come out into the open and join with me in demanding such an inquiry? If not, both the world of science and the general public will know what to think.

HERTHA AYRTON.

41 Norfolk Square, Hyde Park, W., May 23.

[WE did not express an opinion upon the charges made by Mrs. Ayrton, but limited ourselves to a statement of the indictment, and pointed out that it was really directed against the men of science associated with the Gas Service of the Army. Possibly these officers are not free to enter into a discussion of reasons for the neglect of the use of the fans, and nothing short of a public inquiry will elicit the whole of the facts in regard to them.—ED. NATURE.]

A New Method for Approximate Evaluation of Definite Integrals between Finite Limits.

THE subject has a particular interest for naval architects, inasmuch as the majority of calculations relative to displacement, stability, strength, etc., of ships involve the finding of areas and volumes bounded by curved lines and surfaces.

The particular rule enunciated by Mr. A. F. Dufton in NATURE of May 20 has been in use at this college for some years, and gives very accurate results in obtaining areas and volumes, and also, by a further application, the positions of their centres of gravity.

The method of its derivation was from one of Tchebycheff's rules. $f(x)$ in this particular case is taken as $(a+bx+cx^2+dx^3+ex^4)$. It can readily be shown that the value of

$$\int_0^1 f(x)dx = \tfrac{1}{4}[f(x_1)+f(x_2)+f(x_3)+f(x_4)],$$

where,

$$\Sigma x_1 = 2,\ \Sigma x_1^2 = \tfrac{4}{3},\ \Sigma x_1^3 = 1,\ \Sigma x_1^4 = \tfrac{4}{5},$$

whence $x_1 = 0{\cdot}1027$, $x_2 = 0{\cdot}4062$, $x_3 = 0{\cdot}5938$, and $x_4 = 0{\cdot}8973$. The approximation to one-tenth, four-tenths, six-tenths, and nine-tenths was obvious, and all the more welcome because it is our usual practice to divide the ship's half-length into ten sections. No special sections have to be drawn, calculations being readily made with the aid of the existing drawings.

This rule was briefly referred to by Mr. W. J. Luke at a meeting of the Institution of Naval Architects in 1915 (Trans. I.N.A., vol. lvii., p. 210).

The application of Simpson's ordinary rule to find the area of a quadrant or semicircle, as quoted, manifestly shows Simpson's rule at its worst, owing to the wide divergence of the curve from the assumed curve from which the rule is derived. Where curves approximate to these forms, as in many sections of a ship, it is common practice in the use of this rule to interpose intermediate ordinates where the curve is "steep"—relative to the base line—to get greater accuracy.

An interesting paper dealing with this subject and giving a great variety of rules for approximate integration was read at the Institution of Naval Architects in 1908 (Trans. I.N.A., vol. l.) by Sir W. S. Abell entitled "Two Notes on Ship Calculations."

C. F. MERCHANT.

Royal Naval College, Greenwich, S.E.,
May 27.

Applied Science and Industrial Research.

YOUR correspondent Mr. J. W. Williamson says in NATURE of May 27 that much of my criticism of the Department of Scientific and Industrial Research "seems to lend colour" to current misconceptions of industrial research, which he proceeds to construct out of his own imagination, having first fathered them on me, and then submits that the cause of pure science is not well served by inconsiderate attacks on the industrial research movement, such as he would have it believed I made. I judge from this that he was not present at the meeting, and I therefore wish it to be known that the full text of my address to the National Union of Scientific Workers can be obtained by forwarding a stamped addressed foolscap cover to the General Secretary, 19 Tothill Street, Westminster, S.W.1. If Mr. Williamson will have the goodness to read it and the full report of the meeting published in the current issue of the *Scientific Worker*, the official organ of the union, and then say, if he still desires, what he objects to, it would help rather than confuse the issue.

FREDERICK SODDY.

MR. WILLIAMSON'S letter in NATURE of May 27, in which he criticises the attitude of Prof. Soddy and that of the National Union of Scientific Workers towards the Department of Scientific and Industrial Research and the struggling research associations, confuses the issue. To attack the Department or association entrusted with industrial research is tantamount neither to attacking industrial research nor to making invidious distinctions between pure and applied research.

In the minds of the members of this union there exists no belief in the superiority of pure science over industrial research; it has always been our expressed opinion that there is no difference in their scientific value. In one of our explanatory pamphlets this view is expressed: "It [the union] aims at including within a single scheme both academic and technical members. . . . The separation of science and industry has been a principal cause of our disastrous neglect of science in the past, and if continued will remain harmful to both in future. The present organisation, by ensuring the intercourse of the two sides, is therefore desirable on both national and scientific grounds." Embodied in our rules we have as avowed objects: (1) To advance the interests of science, pure and applied, as an essential element in the national life. (2) To promote and encourage scientific research in all its branches.

Our criticism is that in any scheme put forward by the Department inadequate facilities are given to that type of research which, though it has less immediate application, is probably of greater ultimate importance through leading to the better understanding of more phenomena. It would be quite unfair to expect particular industrial research associations to contribute more than others to the prosecution of research which might have a common application to industry or to some aspect of the national life. Obviously this type of work is best carried out at the universities or at institutions such as the National Physical Laboratory. Yet how is this research fostered at the universities? According to the last report of the Department, sixty-eight research workers and their assistants and thirty-five students in training received allowances and grants for equipment amounting to 14,170*l.*; this is at the rate of 53*s.* a week, and includes equipment. Contrast this grant with the salary of 4000*l.* a year for the director of the Glass Research Association—an appointment which is an affront to all scientific workers. Millions have gone into State-protected industries to the accompaniment of an astounding appreciation in the value of the shares held by individuals in the State-aided industry. But the universities are begging for funds to provide decent bench accommodation and instructors for their science students. Speaking at Liverpool on May 28, Dr. Adami is reported to have said that if the university raised the salaries of its demonstrators to a proper standard it would lead to bankruptcy.

It is unfair to suggest that we are criticising the Department for the starvation of pure scientific research because industrial research is fostered; on the contrary, we are anxious for the advancement of both. We are of the opinion that neither branch of science is receiving adequate support, but that research carried out in the general interest is in the more unfavourable position. If we attack the Department it is because we honestly believe it is for the betterment of research—a maximum of efficiency in the administration of the funds available which must inevitably tend towards the better appreciation of science.

At the conference of research associations held under the auspices of the Department of Scientific and Industrial Research on May 14, I heard several representatives express opinions almost identical with those of the National Union of Scientific Workers; suggestions were made and questions asked which are provoked by Prof. Soddy's address. Mr. Williamson himself dealt with the economic position of the research workers, and made suggestions for improvement which might have been those of a member of the executive of this union.

We entirely concur with Sir Frank Heath that the Department of Scientific and Industrial Research is embarked on a great adventure. Mr. Williamson will agree that it is our concern to work for the safety, honour, and welfare of the adventurous scientific workers. So far we have heard too much of the rights of the financial interests concerned to work out their own salvation with money provided largely by the State, but very little of the rights of the scientific workers to safeguard their own interests. We wish to be assured that the leading spirit in the adventure is sufficiently well advised to guide him in his choice of officers for this army of truth-seekers, and that his army is not defeated by ignorance, mishandled by an unsympathetic staff, or starved to feed the parasites of science.

A. G. CHURCH,
Secretary.

National Union of Scientific Workers,
19 Tothill Street, Westminster, London, S.W.1, May 31.

The Great Red Spot on Jupiter.

WHEN this remarkable object came into striking prominence and attracted general observation in 1878, the rate of its rotation period was slightly increasing, and it continued to increase until the end of the century. Then in the early part of 1901 a large irregular spot appeared in the south tropical zone of Jupiter. This new feature, moving swifter than the red spot to the extent of about 23 seconds per rotation, soon affected the motion of the latter by accelerating its rate as it overtook it, and this influence has been repeated prior to the seven occasions on which the two objects have been in conjunction during the last twenty years.

The rate of rotation indicated by the red spot has, in fact, been a very variable feature in recent times, and the marking named has exhibited an increased velocity and a shortening period. In the years from 1894 to 1901 the mean period was 9h. 55m. 41·3s., but in the last eight years it has been 9h. 55m. 35·7s.

I have shown the annual differences in Fig. 1, and the rate of rotation determined each year I have also tabulated for inspection and comparison:

	h.	m.	s.		h.	m.	s.
1878 ...	9	55	33·7	1899 ...	9	55	41·6
1879 ...			34·1	1900 ...			41·4
1880 ...			35·2	1901 ...			40·7
1881 ...			36·3	1902 ...			39·6*
1882 ...			37·3	1903 ...			40·2
1883 ...			38·2	1904 ...			39·7*
1884 ...			39·0	1905 ...			41·2
1885 ...			39·6	1906 ...			39·5*
1886 ...			39·9	1907 ...			40·9
1887 ...			40·1	1908 ...			39·6*
1888 ...			40·2	1909 ...			40·3
1889 ...			40·4	1910 ...			37·4*
1890 ...			40·5	1911 ...			37·4
1891 ...			40·6	1912 ...			37·2
1892 ...			40·8	1913 ...			34·8*
1893 ...			40·9	1914 ...			35·5
1894 ...			41·0	1915 ...			37·5
1895 ...			41·1	1916 ...			36·4
1896 ...			41·3	1917 ...			34·5
1897 ...			41·5	1918 ...			33·7*
1898 ...			41·7	1919 ...			35·5

The values are smoothed up to 1900, but not in later years.

I have placed an asterisk in the table and diagram to those years in which a conjunction occurred between the red spot and the south tropical spot. In every case it will be seen that the red spot moved at a more rapid rate in those years when conjunctions were observed.

The south tropical spot or disturbance is a totally different object both in form and nature, and probably in origin, from the great red spot. The latter has preserved its symmetrical oval form since it was observed by Dawes in 1857, but the former has varied enormously in its length and detail. In 1901 it was scarcely more than 20° long, in 1902 July 87°, in 1903 48°, in 1905 44° to 60°, in 1911 115°, in 1912 65°, in 1913 March 140°, and in 1918 180°, so that in the last-mentioned year it extended half-way round the vast diameter of Jupiter.

This marking exhibited undue faintness in 1918 and the early part of 1919, and it appeared to be on the eve of disappearing, like the hollow in the great south equatorial belt where the red spot lies. However, there has recently been some intensification in the material forming the south tropical spot, so that observations are being made to trace its position and developments. It is satisfactory also to know that the red spot itself continues to retain its definite form, and is sufficiently distinct to be within easy recognition when a steady air conduces to good seeing. This spot seemed to be breaking up or wearing out early in 1919, but it has recovered something of its old-time aspect, and is well within reach of the telescopes usually in the hands of amateurs.

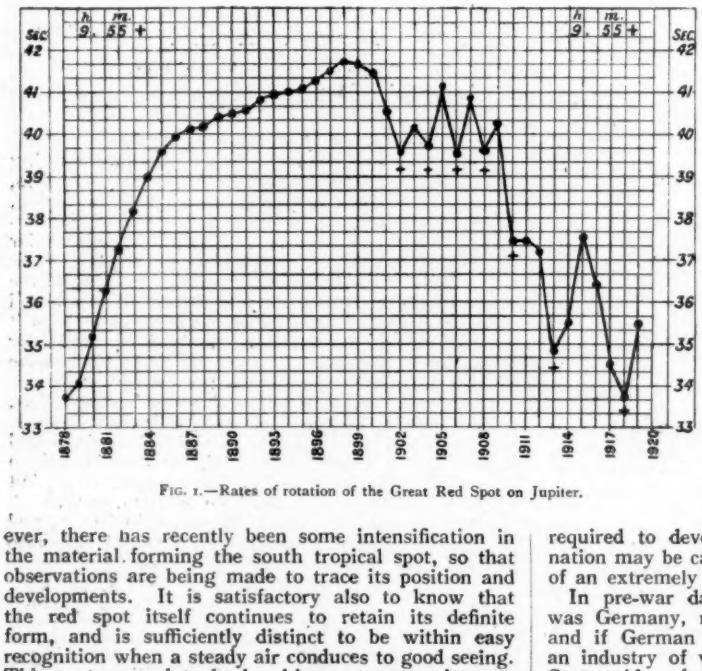

FIG. 1.—Rates of rotation of the Great Red Spot on Jupiter.

Since Schwabe first saw the hollow on the south side of the great south equatorial belt of Jupiter in 1831 September 5, the planet has rotated more than 78,000 times. There is every reason to conclude that the object he saw is the same as that which has been so prominently visible in recent years in close contiguity to the red spot. The two features appear to have participated in one and the same fluctuating rate of rotation, a mean of which was 9h. 55m. 36·8s. during the 88½ years included in the observations.

The observations upon which my deductions for recent years are based were made by the Rev. T. E. R. Phillips and Mr. F. Sargent, and I take this opportunity of acknowledging their kindness in furnishing the necessary materials. My abstention from planetary work has been practically enforced, but, amid the regret caused thereby, I feel great satisfaction in the fact that others are pursuing it with much ability and energy.

W. F. DENNING.

Bristol, May 11.

British and Foreign Scientific Apparatus.

Now that we are living in an age of "trusts" there is no need to fear foreign competition in respect to prices. The only points our home manufacturers should lay stress upon are quality and quantity, and should these be maintained at a high level they can hold their ground against foreign manufacturers; that is, so long as the manufacturers throughout the world have confidence in their respective associations. Whenever these commercial associations begin to fall asunder we may expect competition in prices to operate, and then it will mean a commercial war, not between nations, but between individual manufacturers in Europe and America. The result will mean financial benefit to the users of scientific apparatus, just as the recent slump in prices of the necessaries of life may soon prove to be advantageous to consumers generally throughout the world.

Scientific apparatus is as necessary to the maintenance of healthy life as are hygenic clothing and wholesome food; and if protection for British manufacturers is required in the form of prohibition except under licence to induce them to improve the quality and the output, with the ultimate object of developing an optical industry within the Empire of such importance that there would be less danger to the State in the event of another war, why should the users of scientific apparatus be expected to bear the hardships in regard to poorer quality and higher prices even for a temporary period? Surely it is a question for the Government to decide as to what amount of State aid is required to develop a key industry that the whole nation may be called upon to bear the expense instead of an extremely small minority of the population.

In pre-war days our principal foreign competitor was Germany, not so much in price as in quality, and if German manufacturers were able to develop an industry of very considerable importance without State aid, why cannot British manufacturers do likewise?

There was one person in Germany who was more responsible than all other makers together in lowering prices, viz. Leitz of Wetzlar. He always appeared satisfied with a comparatively small profit, and aimed at a very large output; and, I believe, he was the first to sell 1/12-in. oil immersion objectives at 5*l*., and curiously this ultimately became a uniform price throughout the trade in Europe and America. The same maker sold students' microscope stands at 55*s*., which, with suitable optical equipment, was a serviceable instrument with highest magnifications. The prices of these articles to-day are 9*l*. and 8*l*. 5*s*.—higher than the British equivalents.

Since the armistice German manufacturers have

been obliged to adjust their prices in accordance with the rate of exchange for each country to which they export, and for our country their prices are at present 100 per cent. on average above pre-war English prices. The wages in the German optical industry have increased more than 400 per cent., and are likely to rise still higher. Opticians and mechanics earning the equivalent of 1*s.* per hour before the war now receive 5*s.* 6*d.* and have a working week of forty-eight hours. They are living in a state of semi-starvation, passing through an experience at present much worse than anything we endured in the war, and unless foodstuffs are sent from England and America the Germans may be forced to conditions similar to those experienced by them during the last two years of war, until the next harvest provides better supplies. The low value of German money makes it exceedingly difficult for manufacturers to import raw materials. Many iron and steel works are closed for want of coal, and most of the coal delivered from the mines is what our miners call "dust." The French take the coal and leave the rubbish, "which is good enough for the Germans." Motor lorries are standing idle for want of petrol or benzol; and, for transport, horses are employed instead. Manufacturers do not pay a percentage on excess profits, but have to deliver up the whole of these profits to the State.

I fully appreciate the question which Mr. Baker raises in his letter appearing in NATURE of May 20: "The rate of exchange makes the prices seem low as compared with those in this country, but can Prof. Bayliss obtain delivery at the low prices?" Having spent six weeks recently in the German interior and purchased a considerable quantity of optical apparatus, I found it impossible to get the goods exported to England at the rate of exchange, but had to pay English prices in English money; also it was necessary to obtain licences from the German Government before goods could be exported.

The foregoing statements indicate briefly some of the conditions prevailing in the scientific apparatus trade in Germany, and there is evidence of their having to continue for a very considerable period.

I believe our manufacturers have had the opportunity of a lifetime since the armistice, and there is still time to reorganise British workshops to compete successfully with foreigners without State aid, but with courage, capital, and enterprise.

The proposed Anti-dumping Bill is a misnomer. There is no dumping done in scientific apparatus in our country, and never has been any. We could produce quality equal to or better than that of any other nation if we set ourselves to the task. One example during the war—the best aerial photographic lenses were made by an English firm. Germany came second. The tests were made by disinterested officials in the Royal Air Force. J. W. OGILVY.

Hill View, Westerham Hill, Kent, May 25.

THE letters from manufacturers on the subject of the supply of scientific instruments are interesting and fairly unanimous, but appear to me to miss the whole point of the situation. That is, that after five years' freedom from competition our manufacturers cannot in many classes of scientific instruments compete successfully with German firms.

If the rate of exchange is the cause of the importation of German instruments, what is the cause of hundreds of American microscopes and lenses being sold during and after the war with the rate of exchange adverse to us? The Germans are selling their goods in England at *current English rates* and above, yet find a ready sale. At first, it is true, some individuals smuggled in German instruments at mark rates, but as soon as the extent of the demand was realised, German firms put up their export rates to 60–100 per cent. above pre-war rates, to be paid *in English money*, and by some firms payment in advance is insisted upon. This is more than confirmed by Messrs. Bellingham and Stanley in their letter. What more do our manufacturers want?

The German goods are sold simply because they are superior to similar goods produced at reasonable prices in Britain. Mr. B. H. Morphy and Mr. C. Baker state that this was the case before the war, and most scientific workers will tell them that it is so still.

One firm complains of a voluntary hospital buying apparatus cheaper abroad, and thinks that an English firm should have been given the contract at higher rates. Whose money is to do this? I hope that the voluntary subscribers would protest against their money being paid to subsidise British manufacturers.

A small concrete example of what actually occurs may not be out of place. A German diamond object marker before the war cost 10 marks. Early this year I sent to a leading firm of British opticians for one. It arrived, but was absolutely useless, having no spring safety device and no means of screw adjustment, both present in the German one. It cost 1*l.* 10*s.* Months later, with considerable trouble, I procured from Messrs. Leitz, of Germany, the pre-war article at 100 per cent. advance, namely, 1*l.* The German article was bought because it was superior, not because it was cheaper.

It should be borne in mind that some scientific articles, *e.g.* photographic plates, can be produced well and cheaply here, and need not fear German competition. If, as Mr. Baker states, the profit on other classes of goods is too small, why not allow them to be imported from Germany?

Glasgow, May 21. J. S. DUNKERLY.

Cost of Scientific Publications.

LIKE other societies which exist mainly for the publication of the results of scientific research, the Royal Society of Edinburgh finds its activities greatly hampered by the present cost of publication. The statements contained in the leader in NATURE of May 6 and in the correspondence which has followed it are fully borne out by the experience of this society. Taking into account all present sources of income and all necessary expenses, it may safely be said that the output of scientific literature must be cut down to fully one-third of what it was in pre-war days.

The point to be emphasised is that publication of scientific results is absolutely necessary for the true development of science. A year and a half ago the council of the Royal Society of Edinburgh, on realising the seriousness of the situation, appealed to the Chancellor of the Exchequer for an increase in the annual grant solely in the interest of scientific publication. The appeal was unsuccessful, but in reply the Chancellor of the Exchequer stated that "he would be ready to reconsider the question along with other similar claims when the financial situation is more favourable."

It certainly seems necessary that suffering societies which publish original memoirs should take steps to press on the attention of the nation and on the conscience of the Government this consideration in the interest of scientific investigation, viz. the provision of adequate funds for the publication of the results of research. C. G. KNOTT,

General Secretary.

Royal Society of Edinburgh,
22 George Street, May 31.

Natural History Studies in Canada.[1]

(1) A REVISED edition of Mr. Ernest Thompson Seton's "Arctic Prairies" (first published in 1911) is very welcome. It is a well-told story of a canoe journey of 2000 miles in search of the caribou (a kind of reindeer), and it discloses a cheerful picture of the abundance of wild life (in 1907) in the Far North-west of America. "I have lived in the mighty boreal forest, with its Red-men, its Buffalo, its Moose, and its Wolves; I have seen the Great Lone Land with its endless plains and prairies that do not know the face of man or the crack of a rifle; I have been with its countless lakes that re-echo nothing but the wail and yodel of the Loons, or the mournful music of the Arctic Wolf. I have wandered on the plains of the Musk-ox, the home of the Snowbird and the Caribou."

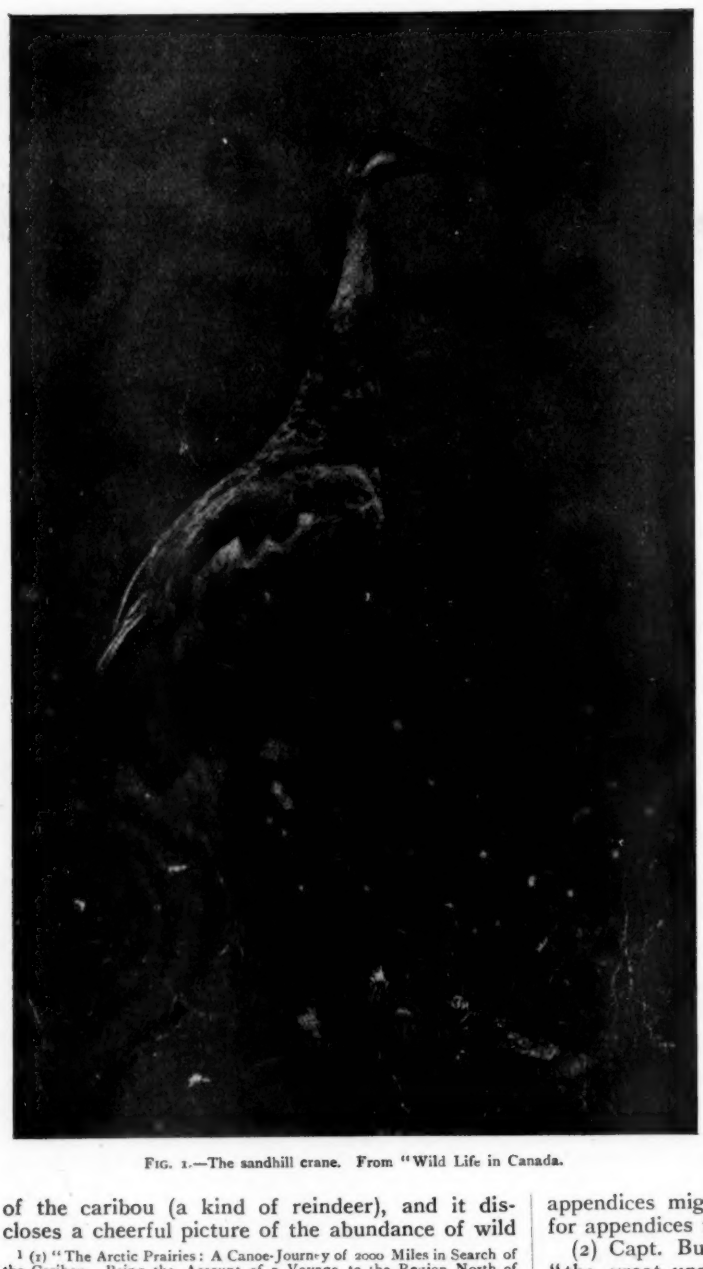

FIG. 1.—The sandhill crane. From "Wild Life in Canada.

The author has fine things to tell us of—such as the love-song of Richardson's owl, sung on the wing, "like the slow tolling of a soft but high-pitched bell"; a herd of wild buffalo amid a great bed of spring anemones; a troop of caribou, about 500 strong, charging at full trot through the taint of man; and the wealth of flowers in the so-called "Barren Grounds." There are grim pictures too—of the malignancy of the mosquitoes which for two and a half months make a hell of a land which for half the year might be an earthly paradise; of the epidemics that periodically wipe out the all too prolific rabbits (billions in the Mackenzie River valley in 1903–4, and none to be seen in 1907); of the Canadian lynx that "lives on rabbits, follows the rabbits, thinks rabbits, tastes like rabbits, increases with them, and on their failure dies of starvation in the unrabbited woods"; of the aged dwarf spruces which testify to the rigour of the environmental conditions, for one which was at least 300 years old was only 8 ft. high and 12 in. through. Mr. Seton's skill as a descriptive naturalist needs no praising, and his narrative is full of human interest as well. The book is generously illustrated with pen-and-ink drawings and photographs. The reference in the preface to the scientific appendices might have been judiciously omitted, for appendices there are none.

(2) Capt. Buchanan tells of his wanderings in "the great unpeopled North, which even to-day comprises more than half of the large Dominion of Canada." He explored the country between

[1] (1) "The Arctic Prairies: A Canoe-Journey of 2000 Miles in Search of the Caribou. Being the Account of a Voyage to the Region North of Aylmer Lake." By Ernest Thompson Seton. Pp. xii+308. (London: Constable and Co., Ltd., 1920.) Price 8s. 6d. net.
(2) "Wild Life in Canada." By Capt. A. Buchanan. Pp. xx+264. London: J. Murray, 1920.) Price 15s. net.

the Saskatchewan River and the Arctic "Barren Grounds," and his collection of birds from the area drained by the Churchill River was the first to be made from that remote region. Of this collection a list is given at the end of the book, and birds predominate throughout the pages of what is really a naturalist's journal—unvarnished, graphic, and with a strong personal note. A chapter is given to the rare sandhill crane, which he saw and heard and stalked. He found the nest and saw the eggs through the field-glass, but, having waited overnight in the hope of the parents returning, he was baulked in the end, for the nest was empty in the morning.

A fine picture is given of Reindeer Lake, a vast sheet of water stretching 140 miles north and south, and 40 miles across at its widest. Its shores form the favoured winter-haunt of the barren-ground caribou (*Rangifer arcticus*), which digs through the snow to get at the white moss and marsh grass. Early in the year the does and yearling fawns begin to move northward, and the bucks follow later.

There is no weather-change urging the northward migration, so it is leisurely; moreover, many of the does are with young. The southward movement of great herds in the fall is largely conditioned by the absence of trees, for an icy crust, difficult to break, forms over the snow. "As the thermometer drops in the Far North and food and shelter become difficult to find, the animals will band together and grow restive, and pause from time to time to sniff the wind from the south with question on their countenance. And one day, with proud heads up and anxious eyes, they will commence their long travel through sheltering forests where snows are soft and food is plentiful beneath its yielding surface."

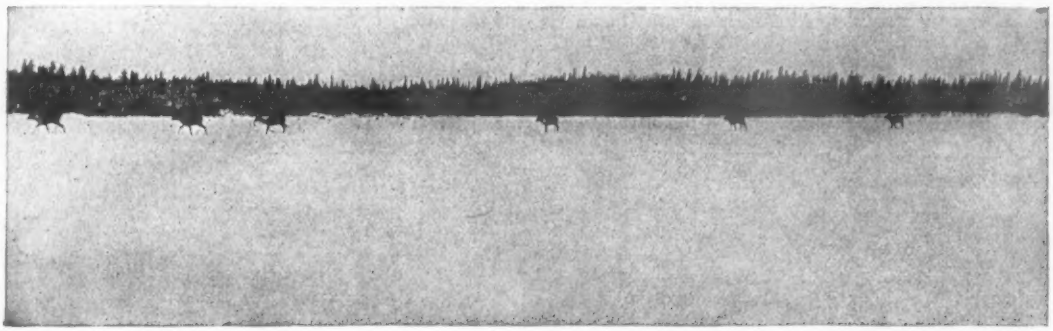

FIG. 2.—Caribou travelling in typical Indian file. From "Wild Life in Canada."

The picture that the author gives of the caribou is a fine piece of work. Another chapter deals with the admirable sled-dogs, which will gamely do their best, for two or three days on end, in bitter weather and without food, to save an anxious situation. Very good reading, too, is Capt. Buchanan's appreciation of the Cree and Chipewyan Indians, "quaintly friendly and unselfish in their hospitality," "resourceful, magnificent fellow-travellers on the trail."

Tidal Power.

THE idea of utilising the rise and fall of the tides for power purposes has long been a favourite one. Up to the present, however, no power development of this kind, of any appreciable size, has been carried out. The comparatively recent arousing of interest in water-power development in general, and the great advance in the cost of fuel, have been accompanied by a corresponding interest in tidal-power schemes, and their commercial possibility is at the moment the subject of serious investigation in this country and in France.

The power which may be developed from a tidal basin of given area depends on the square of the tidal range, and since the cost per horse-power of the necessary turbines and generating machinery increases rapidly as the working head is diminished, the cost per horse-power of a tidal-power installation, other things being equal, will be smallest where the tidal range is greatest. It is for this reason that the western, and especially the south-western, coasts of Great Britain, and the western coast of France, are particularly well adapted for such developments, since the tidal range here is greater than in any other part of the world, with the possible exception of the Bay of Fundy, Hudson's Bay, and Port Gallelos, in Patagonia.

In Great Britain the highest tides are found in the estuary of the Severn, the mean range of the spring tides at Chepstow being 42 ft., and of the neap tides 21 ft. In France the maximum range occurs at St. Malo, where it amounts to 42·5 ft. at spring tides, and about 18 ft. at neap tides. The tidal range in the Dee is 26 ft. at springs, and 12 ft. at neaps, while the mean range of spring tides around the coast of Great Britain is 16·4 ft., and of neap tides 8·6 ft.

Many schemes of tidal-power development have been suggested from time to time. Briefly outlined, the more promising of these are as follows:—

(*a*) A single tidal basin is used, divided from the sea by a dam or barrage, in which are placed the turbines. The basin is filled through sluices during the rising tide. At high tide the sluices are closed. When the tide has fallen through a height the magnitude of which depends on the working head to be adopted, the turbine-gates are opened, and the turbines operate on a more or less constant head until low tide. The maximum output from a given area of basin is

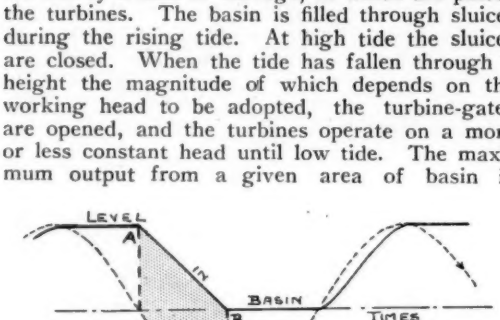

FIG. 1.

obtained when the working head is approximately one-half the tidal range, and the cycle of operations under these conditions, and with a constant rate of fall in the tidal basin, is shown in Fig. 1. Here the dotted sine curve represents the level of the sea on a time base. The working period extends from A to B.

(*b*) A single tidal basin is used, with the turbines operating on both rising and falling tides. The cycle of operations is now indicated in Fig. 2. The working period per complete tide extends from A to B and from C to D. Slightly before low water, at B, the basin is emptied through

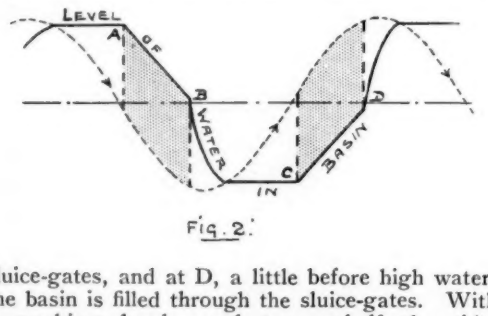

FIG. 2.

sluice-gates, and at D, a little before high water, the basin is filled through the sluice-gates. With a working head equal to one-half the tidal range, the period of operation is approximately 50 per cent. greater than in system (*a*), and the work done per complete tide is approximately 50 per cent. greater.

(*c*) A single tidal basin is used with the turbines operating on both rising and falling tides. Instead of filling and emptying the tidal basin through sluice-gates at high and low water, and working under an approximately constant head, the water is allowed to flow through the turbines and to adjust its own level. Under these conditions the rise and fall inside the basin are cyclical, with the same period as the tide, but with a smaller rise and fall and with a certain time-lag. The range in the basin and the time-lag depend on the ratio of the surface area of the basin and of the effective discharge area of the turbines. The working head during each tide varies from zero to a maximum. The cycle of operations is shown in Fig. 3. The working period is from A to B and from C to D, where the head at the points A, B, C, and D is the minimum under which the turbines will operate. The total working period per tide is greater than with either of the preceding

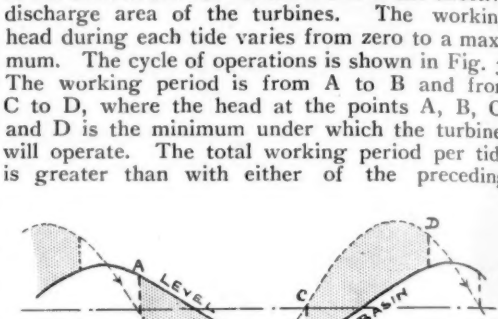

FIG. 3.

systems, and the possible output is somewhat greater. On the other hand, the variation of head during any one tide is very large.

(*d*) Two tidal basins of approximately equal areas are used, with turbines in the dividing wall. Each basin communicates with the sea through suitable sluice-gates. In one of these basins, called the upper, the water-level is never allowed to fall below one-third of the tidal range, while in the lower basin the level is not allowed to rise above one-third of the tidal range. The working head then varies from 0·53 H to 0·80 H, and operation is continuous, as indicated in Fig. 4, which shows the cycle of operations. The upper

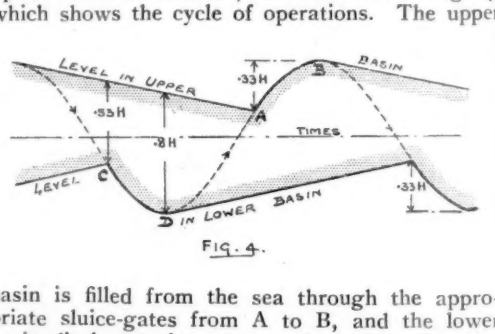

FIG. 4.

basin is filled from the sea through the appropriate sluice-gates from A to B, and the lower basin discharges into the sea from C to D. For a given total basin area and a given tidal range the output is only about one-half that obtained in system (*a*), and one-third that obtained in systems (*b*) and (*c*), so that, except where the physical configuration of the site is particularly favourable, the cost per horse-power is likely to prove very high.

(*e*) Two tidal basins of approximately equal size are used. Turbines are installed in the walls dividing the sea from each basin. Fig. 5 shows

the cycle of operations. From A to B the upper basin discharges through its turbines into the sea. From B to E the sea enters the lower basin through its turbines. The upper basin is filled from the sea through its sluice-gates between C and D, and the lower basin is emptied through its sluice-gates from F to G. The head varies from 0·25 H to 0·62 H, and the output is some 25 per cent. greater than in system (*d*), but the number of turbines required is much greater than in (*d*).

It is possible, at the expense of additional complication, to arrange in each of these systems that the head shall be maintained constant during any one working period, but since this means that the working head must then be the minimum obtaining during the period, a loss of energy is involved, with a great additional cost of construction and complication in manipulation, and with little compensating advantage.

The great difficulty in developing a tidal scheme as compared with an orthodox low head water-power scheme arises from the relatively great fluctuations in head. In any scheme in which the working head is a definite fraction of the tidal range, the working head at spring tides is much

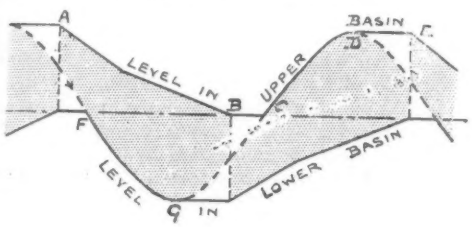

FIG. 5.

greater than at neap tides. In the case of the Severn, for example, the working head at springs would be twice as great as at neaps, and the energy output per tide would be four times as great at springs as at neaps, while at St. Malo the output would be 5·5 times as great at springs as at neaps.

Not only is the installation subject to this cyclical fluctuation of head, but in any simple scheme the turbines also cease to operate for a more or less extended period on each tide; and as this idle period depends on the time of ebb or flood tide it gradually works around the clock, and will, at regular intervals, be included in the normal industrial working day. It is true that schemes of operation such as have been indicated are feasible in which this idle period may be eliminated and continuous operation ensured, but only at a considerable reduction of output per square mile of tidal basin area. Even in such schemes, unless the working head is fixed with reference to the tidal range at neap tides, the variation of head between springs and neaps causes the output to be very variable.

In any installation, then, designed for an ordinary industrial load, unless the output is cut down to that obtainable under the minimum head available at the worst period of a neap tide, in which case only a very small fraction of the total available energy is utilised and the cost of the necessary engineering works per horse-power will, except in exceptionally favourable circumstances, be prohibitive, some form of storage system forms an essential feature of the scheme.

Various storage systems have been suggested. Electrical accumulators must be ruled out, if only on account of the cost, and the same applies to all systems making use of compressed air. The only feasible system appears to consist of a storage reservoir above the level of the tidal basin. Whenever the output of the primary turbines exceeds the industrial demand, the excess energy is utilised to pump water into the reservoir, and when the demand exceeds the output from the primary turbines it is supplied by a series of generators driven by a battery of secondary turbines operated by the water from the storage reservoir.

Evidently this method is available only when the physical configuration of the district affords a suitable reservoir site within a reasonable distance of the tidal basin. Unfortunately also, considerable losses are inevitable in the process, and the energy available at the switchboard of this secondary station is only about 50 per cent. of the energy of the water utilised by the primary turbines. Where two tidal schemes at some distance apart differ sufficiently in phase, it is possible, by working the two in conjunction, to reduce or eliminate the idle period between tides, and thus to reduce the necessary storage somewhat; but this does not affect the necessity of storage as between spring and neap tides.

Since storage reduces the available output by one-half, and at the same time complicates the system, besides adding considerably to the first cost and maintenance charges, the prospects of tidal-power schemes would be much more promising if the whole of the output could be utilised as it is generated. By feeding into a distributing main in conjunction with a large steam station and/or inland water-power scheme, and delivering to an industrial district capable of absorbing a comparatively large night load, such a state of affairs might be realised, at all events approximately. There is also the possibility that the intermittent operation of certain electro-chemical processes may be developed so as to enable any surplus power to be absorbed as and when available, and, if so, power developed tidally will probably prove cheaper in this country than that developed from any other source.

Owing to the relatively large variations in working head in any simple scheme, and to the small working heads, the design of hydraulic turbines capable of giving constant speed with reasonable efficiencies, and of moderately high speeds of rotation, is a matter of considerable difficulty. Modern developments, however, promise much better results in both these respects than would have appeared possible only a few years ago, and turbines are in existence

which are capable of operating under a variation of head equal to 50 per cent. on each side of the mean, with efficiencies which do not fall below 70 per cent. over this range, and with reasonably high speeds of rotation under the heads available.

Even with such turbines, the number of technical problems to be solved before a tidal scheme of any magnitude can be embarked upon with confidence is large. The questions of single-*versus* double-way operation, of storage, of the effect of sudden changes of water-level due to strong winds, of wave effects, of silting in the tidal basin and of scour on the down-stream side of the sluices, of the best form of turbine and of generator, and of their regulation and of that of the sluice-gates, are probably the most important, though not the only, subjects to consider.

On the other hand, the possibilities of tidal power, if it can be developed commercially, are very great. Assuming a mean tidal range of only 20 ft. at springs, and 10 ft. at neaps, and adopting the single-basin method of development with operation on both rising and falling tides, each square mile of basin area would be capable, without storage, of giving an average daily output of approximately 110,000 horse-power-hours. In such an estuary as the Severn, where an area of 20 square miles could readily be utilised with a spring tidal range of 42 ft., the average daily output, without storage, would be approximately 10,000,000 horse-power-hours.

At the present time it is difficult to obtain an even rough estimate of the total cost of such a scheme, owing to the uncertainty regarding many of the factors involved. The whole question would appear to merit investigation, especially on matters of detail, by a technical committee with funds available for experimental work. As a result of such an investigation, it is at least possible that a definite working scheme could be formulated capable of generating power at a cost at least as small as, and possibly much smaller than, that of power generated from any coal-fired installation.

Obituary.

PROF. C. A. TIMIRIAZEFF, FOR.MEM.R.S.

THE death is announced of Clement Arkadievitch Timiriazeff, emeritus professor of botany in the University of Moscow. Timiriazeff was the only Russian botanist who was at all a familiar figure in England. In earlier days he came to England and saw Charles Darwin, while his last visit was made as a delegate to the Darwin celebration in Cambridge in 1909. His earliest publication appeared in 1863—a Russian book on "Darwin and his Theory," which ran through five editions. Here he made his mark as an attractive expounder of science for the general reader, and he followed this work with books on "The General Problems of Modern Science," "Agriculture and Plant Physiology," and "The Life of the Plant." The last was in great demand, there being seven Russian editions between 1878 and 1908, while in 1912 it was translated into English, and is widely read to the present day. Its characteristic note is an exposition of plant structure and function based on the chemical and physical processes at work in the living plant. Without comparison of the early editions we cannot tell at what date this book took the form in which it appeared in English, but it looks as if Timiriazeff was one of the earliest writers to take up this essentially modern outlook. His attitude was no doubt an expression of his early training under chemists and physicists. Born in 1843, he studied under Bunsen, Kirchhoff, Helmholtz, and Berthelot before working with Boussingault.

Timiriazeff made himself famous by work on one single problem—the participation of the different rays of the visible spectrum in the photosynthetic activity of the green leaf. The technique which he brought to the attack on this problem seems almost an exact expression of the combined influence of his teachers: good methods of gas-analysis, pure spectral illumination, and experimentation on isolated leaves; combined with the sound conception that rays utilised for work in the chloroplast must be rays abundantly absorbed by the pigment chlorophyll. Working with a micro-eudiometer, concentrated sunlight, and a narrow spectroscope slit, he was able to disprove the accepted view that the yellow region, which is so bright to the eye, is the most effective region of the solar spectrum, and to locate the efficiency in the red region where absorption by chlorophyll is greater. Afterwards he demonstrated the secondary maximum of photosynthetic effect in the blue region, where also absorption is great.

This work was published in different forms, at various dates, in scientific journals of most European countries, the final presentation being the Croonian lecture to the Royal Society in 1903. The actual experimental work seems to have been all done between 1868 and 1883. There is no evidence that he published research work on any other subject, so that we have in Timiriazeff the remarkable case of a man who, having achieved fame by one important line of research at forty, was content to devote the remaining half of his life to teaching and exposition.

THE announcement of a new book, "A Nation's Heritage," by HARDWICKE DRUMMOND RAWNSLEY, sadly coincides with the record of its author's death. Born on September 28, 1851, the distinguished canon died on May 28, to the last pursuing the self-imposed task of persuading his fellow-countrymen to take care of their own treasures. His mother was a niece of Sir John Franklin, the Arctic explorer. In education Canon Rawnsley had the good fortune to be at Upping-

ham under Edward Thring, and at Balliol under Benjamin Jowett, with fellow-undergraduates who in various ways became men of light and leading. As a poet and preacher, and in general a quickener of life and energy wherever demands were made upon his active genius, he met with well-deserved appreciation. As the obituary notice in the *Times* observes, "perhaps his chief work was the founding of the National Trust for the Preservation of Places of Historic Interest and Natural Beauty." For the qualifying word "perhaps" it would be better to substitute the word "undoubtedly." Men like Canon Rawnsley, by setting a courageous example, often accomplish much more than their immediate object.

BY the death, at fifty-eight years of age, of DR. GEORGE ERNEST MORRISON, "Morrison of Peking," as he was familiarly known, the Empire has lost a great explorer and expert in the politics of the Far East. An Australian by birth, Dr. Morrison began by explorations in that continent, New Guinea, and the South Sea Islands, his most notable exploit being his famous crossing from the Gulf of Carpentaria to Melbourne in 1882, when he marched 2043 miles on foot in 123 days. Coming to Europe, he took his degree of M.D. at Edinburgh, and wandered in the United States, Spain, and Morocco. Reaching China, he crossed to Rangoon and explored Siam. His life-work really began in 1897, when he was appointed correspondent of the *Times* at Peking. Here he recorded from day to day with the prescience of a statesman and the accuracy of a historian the momentous struggle which resulted from the German occupation of Kiao-chao, and he took an active part in the defence of the Peking Legations during the Boxer rising of 1900. In 1907 Dr. Morrison crossed China from Peking to Tonquin, and in 1910 he rode from Honan City to Andijan in Russian Turkestan. Two years later he resigned his post as correspondent of the *Times*, and became political adviser to the first President of the Chinese Republic. During his stay in Peking he collected one of the most comprehensive libraries of Chinese literature. His contributions to the study of the Far East, except his well-known book, "An Australian in China," largely consist of newspaper articles.

WE much regret to announce the death, on May 28, in his forty-third year, of PROF. LEONARD DONCASTER, F.R.S., fellow of King's College, Cambridge, and Derby professor of zoology in the University of Liverpool.

WE notice with regret the announcement in the *Times* of the death in India, at the early age of thirty-two years, of PROF. SRINIVASA RAMANUJAN, F.R.S., fellow of Trinity College. Cambridge, and distinguished by his brilliant mathematical researches.

Notes.

THE Romanes lecture at Oxford was delivered on May 27 by Dr. Inge, Dean of St. Paul's, before a large audience, by whom the lecturer's brilliant epigrams and trenchant criticism of conventional catchwords were evidently much appreciated. Dealing with the "idea of progress," the Dean made it clear that he had no belief in any natural law of continued progress in the sphere of morals or intellect, or even of physical organisation. The conception of such a law was, in fact, of comparatively recent growth, and had no foundation in the thought of antiquity or of the Middle Ages. At the same time he would not deny a temporary improvement of the race in fulfilment of a finite purpose, though he found little or no evidence of any advance during the historical period in either physical organisation or morals. The results of accumulated experience must not be confounded with a real progress in human nature. Dean Inge would scarcely be concerned to deny that the emergence of rational humanity from previous non-human conditions deserved in some sort the name of "progress," but he saw no warrant for the belief that such "progress" would be continued indefinitely under the domain of natural law. Huxley had pointed out in a previous Romanes lecture that ethical improvement ran counter to the process of cosmic evolution. Progress was a task for humanity, not a law of Nature. Civilisation was a disease that had hitherto been invariably fatal. The ancient civilisations had fallen by the attacks of outer barbarians; "we breed our own barbarians." But progress was possible for the individual, if not for the race, and hope was not only a virtue, but also a solid fact.

ON May 17 Mr. H. Morris, of Lewes, read a paper to the Oxford University Archæological Society on the evolution of Wealden flint culture from pre-Palæolithic times, including that of Piltdown Man. He exhibited many flints, which he claimed as intermediate between the early Harrison types of the North Downs plateau and the recognised Palæolithic types, representing man's transition from the stage in which he subsisted on a vegetable diet to the hunting stage. The earliest spear-head accompanies the Piltdown skull and marks the beginning of man the hunter. The flints are confined to a limited number of patches, and many prolific "river gravel" areas fail to produce anything resembling them; the proportions in which the various types appear are found to agree closely in all the patches. When the cortex of the flint did not interfere with the design of the implement, it has been cleverly and intentionally preserved; many of the fractures are of thermal origin, but man utilised these natural fracture-surfaces in the same way as he utilised cortex. It is significant that signs of man's work appear only in the places where it is essential for the attainment of the required form. Sir Arthur Evans, Prof. Sollas, Dr. Marett, Mr. Henry Balfour, Mr. Reid Moir, and others discussed Mr. Morris's paper, and hesitated to accept his conclusions.

A SUDDEN flood swept through the Lincolnshire town of Louth on Saturday afternoon, May 29, causing immense havoc in its path. The torrent took the course of the small stream known as the River Lud, which runs through the town, and rose 15 ft. in half an hour. The disaster, which occurred shortly before 5 o'clock, is described as a huge wall of water sweeping down upon the town and carrying away bridges and buildings opposed to its course. The River Lud in normal times is a stream from 12 ft. to 15 ft. wide, and about 2 ft. or 3 ft. deep. The flood is said nowhere to have been less than 8 ft. to 10 ft. high and fully 200 yards wide. It was apparently accompanied by no warning sound, and the torrent of water is said to have exceeded the rate of 40 miles an hour. The loss of life is reported to be from 25 to 40 persons, and the damage to property is roughly estimated at 250,000*l.* to 500,000*l.* A heavy thunderstorm had raged for two hours in the afternoon. The disaster was, without doubt, due to intense thunderstorm rains swelling the river far beyond the capacity of its channel. The "Meteorological Glossary" published by the Meteorological Office describes a "cloud-burst" as a term commonly used for very heavy thunder-rain, and in this sense the term seems applicable to the cause of the Louth disaster.

THE new by-laws of the Chemical Society came into force on June 1, and women are now eligible for fellowship of the society.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday next, June 5. The observatory will be open for inspection by invited visitors at 3.30 p.m.

DR. FREDERICK G. COTTRELL has been nominated by President Wilson as Director of the U.S. Bureau of Mines, Department of the Interior, in succession to Dr. Van. H. Manning, resigned.

THE Stewart prize of the British Medical Association has been awarded by the council to Dr. Harriette Chick, who has been an assistant in the department of experimental pathology at the Lister Institute since 1906, and has published numerous papers on bacteriology and physical chemistry.

BY the courtesy of the council of the Institution of Mechanical Engineers, the next ordinary scientific meeting of the Chemical Society on June 17 at 8 p.m. will be held in the lecture-hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, when Prof. J. C. McLennan, of Toronto University, will deliver a lecture on "Helium."

A JOINT meeting of the Association of Economic Biologists and the Imperial Entomological Conference will be held at the Rothamsted Experimental Station, Harpenden, on June 4. The party will leave St. Pancras Station by the 10 a.m. train and, on arrival at Harpenden, proceed direct to the park, where the experimental plots will be demonstrated by Dr. W. E. Brenchley.

SIR WILLIAM J. POPE has accepted the nomination of the council of the Society of Chemical Industry to be president for the year 1920–21. Prof. H. Louis has been elected foreign secretary in succession to the late Dr. Messel, and Dr. C. C. Carpenter has been appointed the society's representative on the governing body of the Imperial College of Science and Technology.

AT the meeting of the Franklin Institute, Philadelphia, on May 19, the Franklin medal awarded to the Hon. Sir Charles A. Parsons was received by Sir Auckland Geddes, British Ambassador; and Mr. W. A. F. Ekengren, Swedish Minister, also received a Franklin medal for Prof. Svante A. Arrhenius. Papers were presented on "Some Reminiscences of Early Days of Turbine Development" by Sir Charles A. Parsons, and on "The World's Energy Supply" by Prof. Arrhenius.

THE national memorial to the late Capt. F. C. Selous at the Natural History Museum, Cromwell Road, South Kensington, will be unveiled by the Right Hon. Viscount Grey of Fallodon, K.G., on Thursday next, June 10, at 3.30 p.m. The presentation will be made by the Right Hon. E. S. Montagu, M.P., chairman of the committee. The granite of the bas-relief which forms the memorial is from the Matoppo Hills, the burial-place of Cecil Rhodes and Sir Starr Jameson, and was presented to the Selous Memorial Committee by the Government of the Union of South Africa.

THE Imperial Entomological Conference was opened in London on Tuesday, June 1, by Lord Harcourt. The official delegates to the conference are:—Canada, South Africa, Basutoland, Bechuanaland, and Swaziland, Mr. C. P. Lounsbury; Australia, Prof. R. D. Watt; New Zealand, Dr. R. J. Tillyard; India, Mr. C. F. C. Beeson; Queensland, Mr. F. Balfour Browne; British Guiana, Mr. G. E. Bodkin; Ceylon, Mr. F. A. Stockdale; East Africa Protectorate, Mr. T. J. Anderson; Federated Malay States, Mr. P. B. Richards; Gold Coast, Mr. W. H. Patterson; Imperial Department of Agriculture for the West Indies and Leeward Islands, Mr. H. A. Ballou; Mauritius, Mr. G. G. Auchinleck; Northern Rhodesia, Dr. Aylmer May; Southern Rhodesia, Mr. R. W. Jack; Seychelles, Dr. J. B. Addison; Sierra Leone, Mr. H. Waterland; Straits Settlements, Mr. P. B. Richards; Sudan, Mr. H. H. King; Trinidad, Mr. F. W. Urich; and Uganda, Mr. C. C. Gowdey.

IN the May issue of the *Fortnightly Review* Mr. Edward Clodd gives an account of the prevalence of occultism at the present day. This results from the fact that though man calls himself *Homo sapiens*, his instincts and elemental passions and emotions remain primitive. Prof. Elliot Smith in a recent paper on "Primitive Man" remarks that, "so far as one can judge, there has been no far-reaching and progressive modification of the instincts and emotions since man came into existence beyond the acquisition of the necessary innate power of using more complex cerebral apparatus which he has to employ." *Plus ça change, plus c'est la même chose.* The influence of the present movement, and the mischievous play on the hopes and fears of crowds of dupes of all classes of society, are strongly reprobated. "Its exponents lack the harmlessness of the cranky theory-

mongers who, if they have wasted our time in the pamphlets they thrust upon us, at least in some degree condone this nuisance by the amusement which they supply."

SIR W. RIDGEWAY AND DR. L. D. BARNETT have reprinted a paper read by them before the Cambridge Philological Society on "The Origin of the Hindu Drama: Additional Evidence." The theory that this type of drama had its origin in dances connected with the cult of the dead is supported by a new series of facts. Krishna, whether he be regarded as a deity from all time or merely a vegetation abstraction, was, as was suggested by S. Lévi in 1892, the chief element in the Hindu drama. The defeat of the Asura demons by Indra took a dramatic form, in which the god's flagstaff became the emblem of the stage, recalling the pole known to the Japanese as Mitegura, "Lordly-Cloth-seat," and to the Chinese Gohei, "Imperial Presence." In the same way the Vīr, or spirits of men who died on the battlefield, are "danced" by the Mahrattas. Other evidence to the same effect has been collected from other parts of India, and the writers sum up the discussion by remarking that "there can therefore be no longer any doubt that Hindu serious drama arose in the worship of the dead."

IN the Journal of the Royal Society of Antiquaries of Ireland (vol. xlix., part 2, December, 1919) Mr. R. J. Kelly, K.C., discusses the question of the famous Donnybrook Fair. On the authority of the great Irish scholar, Dr. Todd, the name seems to be derived from Domhnach broc, "the Church of Broc," a saint who seems to have flourished before the eighth century. By a charter of Prince John, bearing date 1192, the city of Dublin was authorised to establish a fair "at Doniburn annually to continue for eight days on the Feast of the Invention of the Holy Cross," and this was confirmed by a charter, 26th of Henry III., dated 1241. The rude merriment, crime, and degradation which occurred during the fair finally led to its abolition in 1855, after it had lasted nearly six and a half centuries. Mr. Kelly's article contains an excellent collection of extracts from contemporary writers describing the famous fair. Further details are given in the same issue of the journal in an article by Mr. H. Bantry White on "An Old House at Donnybrook."

MISS ANNE L. MASSY gives (Sc. Proc. Roy. Dublin Soc., vol. xvi., No. 4, April, 1920) a revised list of the twenty-five species of Holothurioidea ("sea-cucumbers") of the coasts of Ireland. Since the publication in 1905 of Mr. Kemp's paper on the Echinoderms of the west coast of Ireland, the naturalists of the Fisheries Branch of the Department of Agriculture have taken three species of Holothurians which are new to the British and Irish area, namely, *Stichopus regalis*, *Mesothuria Verrilli*, and *Benthogone rosea*. The first of these occurs in the Mediterranean, and is known as far south as the Canaries, but has not hitherto been observed north of the Bay of Biscay. The other two appear to inhabit the warmer parts of the Atlantic, and probably reach their northern limit at about 52° N.

DR. H. A. PILSBRY'S "Review of the Land Mollusks of the Belgian Congo, chiefly based on the Collections of the American Museum Congo Expedition, 1909-1915" (Bulletin of the American Museum of Natural History, vol. xl., art. 1, 1919), is a very important contribution to our knowledge of the African fauna. The collections on which it is based are very extensive, comprising more than 6000 specimens representing 214 species and subspecies, and a complete record of all the land molluscs hitherto known from the region (compiled by Dr. J. Bequaert) is included. Large numbers of carefully preserved spirit-specimens were available, and Dr. Pilsbry was able to study the anatomy of the soft parts with important results. In the case of the Helicidæ, of which the tropical African representatives have hitherto been known by the shells alone, he has been able to show that their affinities are not, as had been supposed, with the European genera of the family, but with the Asiatic. The field notes are contributed by Mr. Herbert Lang, whose account of the bionomics, economic uses, and folk-lore of the giant Achatinidæ is of particular interest. His remarks on the dispersal of certain species over large areas by the agency of man are worthy of note as having possibly a wider application. The memoir is very fully illustrated, and some of the coloured plates are of exceptional beauty.

WE seem to have much to learn about even the commonest of marine organisms, and the exceedingly abundant and almost cosmopolitan protozoon Noctiluca—a frequent cause of luminescence in the sea—has just received at the hands of Prof. C. A. Kofoid, of the University of California, a new interpretation which, if accepted, will necessitate a change in classification involving the removal of that supposed Cystoflagellate from its accustomed position and its incorporation in another group of the Flagellata ("Noctiluca," Univ. of Cal. Publicns. in Zool., vol. xix., No. 10, February, 1920). Prof. Kofoid is the recognised authority on the groups in question, and no one is more competent to express an opinion on the matter. In describing several new and remarkable genera of the Dinoflagellata from the Pacific related to Gymnodinium, he points out that Noctiluca may have its essential morphological characters homologised with those of various new highly specialised tentacle-bearing forms, such as *Pavillardia tentaculifera*. Noctiluca, then, according to these new investigations, is not exceptional amongst Dinoflagellates in bearing a tentacle, and may be interpreted as having a girdle, a sulcus, and two flagella like any other more ordinary Peridinian. The statement, however, that the "tooth" or prehensile organ represents the degenerate transverse flagellum may possibly be regarded as open to doubt. The acceptance of this work means that the order Cystoflagellata, established by Haeckel in 1878 for the reception of Noctiluca, and adopted by most writers since, should be either suppressed or emended. Noctiluca is no longer its type for text-book and lecture.

A CONCISE record of botanical exploration in Chile and Argentina is given in the *Kew Bulletin* (1920, No. 2) by W. B. Turrill. Among the earliest explorers

were the French botanist, Philibert Commerson, who was surgeon and naturalist to Bougainville's expedition (1767–68), and Sir Joseph Banks, who with Daniel Solander accompanied Cook on his first voyage round the world (1768–71), and brought home extensive botanical collections from the southern hemisphere. The collections of the Spanish naturalists, Ruiz and Pavon, at the close of the eighteenth century were the foundation of an important work on the flora of Peru and Chile. John Miers spent several years in La Plata and Chile, accumulated a large herbarium (now at the British Museum), and published monographs of various South American families of plants. Charles Darwin visited Argentina, Chile, and Patagonia, and Sir Joseph Hooker in his work on the Antarctic flora contributed largely to our knowledge of the botany of the Magellanic area. Valuable botanical exploration was also carried out by collectors sent out by the firm of Veitch—William Lobb and Richard Pearce. The Philippis, father and son, worked for nearly fifty years, collecting and publishing extensively on the flora of Chile. These are a few only of the long list of botanists and collectors chronicled by Mr. Turrill, who, in conclusion, points out that there is still scope for botanical exploration, especially on the Argentine side of the Andes.

In view of the present high prices of sugar, considerable interest is being taken in the question of the possibilities of sugar-beet production in England. The Weekly Service for April 3 from the Ministry of Agriculture and Fisheries contains some useful information on this point. Even apart from the production of sugar, sugar-beet is a useful crop to grow. The food for stock would not be materially reduced by substituting sugar-beet for roots in the rotation, while both leaves and by-products make excellent cattle food. To ensure good crops the land has to be very thoroughly cultivated—a process which reacts favourably on subsequent crops—and there is the further advantage that the crop gives a direct monetary return. Extensive trials were made before the war, and these showed that many parts of the country are suitable for large-scale production of sugar-beet for the manufacture of sugar; but it must be clearly understood that, owing to the bulky nature of the crop and the consequent difficulties of transport, it is advisable to grow beet for sugar production only when the land is within reasonable transport distance of a factory.

Students of the continental deposits of the Old Red Sandstone and Triassic days may well take note of the illustrative matter provided in South Africa and described concisely by Mr. Wm. Torrance ("Observations on Soil Erosion," Union of S. Africa, Dept. of Agric., Bull. 4, 1919, price 3*d*.). The numerous photographs are small; but some, like that of the infilled vlei at Grootfontein, are highly suggestive.

Among the many well-produced Water-Supply Papers of the United States Geological Survey which have reached us are several dealing particularly with the surface water-supply for the year ending September 30, 1916. Work of this nature was begun many years ago in connection with studies of irrigation problems in arid areas, but a particular effort was made in 1915–16 to obtain synchronous observations of the flow of streams. The data supplied for each gauging station in the area covered by each report include a description of the station and tables giving the daily, monthly, and yearly discharge. Illustrations of current meters and water-stage recorders are given.

The reclamation of salt soils is an important agricultural problem in India. Without a soil survey it is impossible to say what area is affected, but in Sind, and to a less extent in the Punjab and the United Provinces, it must be considerable. These so-called alkali lands are either uncultivable or injurious to the growth of crops. "Notes on Practical Salt-Land Reclamation" is the title of a paper published as Bulletin No. 91 by the Agricultural Research Institute, Pusa. Mr. G. S. Henderson, the author of the paper, examines the methods employed in Egypt in the reclamation of Lake Aboukir in the Nile delta, and draws some useful conclusions as to comparable work in India. He insists that the Egyptian method of washing the salt into the subsoil is the only effective way of dealing with the problem. Periodical surface washing is unsatisfactory. It is pointed out, however, that until the Indus barrage is completed there is not enough water in Sind for this purpose, all the available supply being required for irrigation.

The Germans during the war, when materials were short, gave a certain amount of attention to the utilisation of blast-furnace slags, and succeeded in obtaining a satisfactory cement after many experiments. A new use for slag is foreshadowed in an article in *Stahl und Eisen* (March 4), viz. for the manufacture of light bricks for building purposes. By passing molten slag horizontally through water, the steam generated blows out or extrudes the slag jet, and forms what the Germans term "spume" slag or artificial pumice-stone. This material has been patented under the name of "thermosite," owing to its excellent heat-insulating properties. The patentee has also invented a press for pressing bricks formed of small pieces of this artificial pumice and a mixture of slag, sand, and slaked lime which is used as a binder. The bricks thus formed are strong and light, and resemble in their properties the alluvial (tuff) stone obtained in the neighbourhood of Andernach. As, in addition, they can be pressed to large dimensions, less mortar will be required in building operations. The German authorities have approved of the new type of brick for house-building.

In the *Revue générale des Sciences* for April M. Florentin gives an interesting account of the French experience of German gas warfare, with full chronological details of its development and an account of the properties of the substances used, as well as of their mode of manufacture. The section of the French Gas Service under M. Kling, director of the Paris Municipal Laboratory, examined about 2400 samples of material, of which half were shells and projectiles, M. Grignard devoting himself specially to the detection

of impurities which might reveal the modes of manufacture. Reference is made to the Central Laboratory of the British at Hesdin under the late Prof. Watson, and the great rapidity with which new enemy materials were detected is attributed to the excellent *camaraderie* which always prevailed between the French and British Gas Services. The article also contains a summary of the report of the French Mission on the chemical works in the area of occupation, including statistics of the output. In conclusion, M. Florentin expresses the hope that the war has demonstrated the inseparability of chemistry and national defence and the importance of developing the scientific and industrial research which was initiated in France by gas warfare.

WE have received from Messrs. Wood Bros. Glass Co., Ltd., of Barnsley, a copy of their catalogue of English chemical glassware. The list of apparatus is a comprehensive one, well-arranged and neatly illustrated. Judging by the particulars given, chemists should have no difficulty in obtaining any of the usual flasks, beakers, burettes, gas pipettes, absorption tubes, or other glass instruments employed in the laboratory from the selection offered; and as regards any special apparatus in glass that experimenters may want the makers invite inquiry. Messrs. Wood are old-established glass manufacturers who took up the making of chemical glassware in 1915, and they claim that, following the indications given by Sir Herbert Jackson's work on the composition of various special kinds of glass, supplemented by the investigations of their own staff, they are able to produce ware superior to the best Jena glass in its resistance to the action of strong chemicals. It does not withstand sudden extreme changes of temperature quite so well, but will, it is claimed, stand being plunged whilst at a temperature of 150° C. into cold water, and this is more than sufficient for all ordinary requirements. The shapes and designs of ware adopted are those approved by the Glass Research Committee of the Institute of Chemistry, and it would appear generally that the aim of the makers is the praiseworthy one of producing apparatus of high quality in close relation to scientific needs. A feature is made of standard volumetric apparatus verified and stamped by the National Physical Laboratory.

MR. S. EVERSHED read a paper on permanent magnets in theory and practice to the Institution of Electrical Engineers on May 13. He practically adopts Ampère's theory that the molecules of iron in a magnet are equivalent to electric circuits of no resistance in which electric currents are always flowing. On this hypothesis, and adopting Hopkinson's formula connecting magneto-motive force, reluctance, and flux, he discusses the design and predetermination of permanent magnets. He points out that since in practice the demagnetisation curve of the steel is known, the problem that has to be solved is to find the shape of the minimum volume of steel required to produce a given quantity of external magnetic energy. By making assumptions as to the reluctance of the paths of the magnetic flux, Mr. Evershed proves that the performance of a permanent magnet can be predicted in certain cases with accuracy. We are not sure, however, whether this is due to the fact that the errors made in his assumptions cancel out one another. We fail to understand his formula for the magnetic conductance between two spherical poles. It would be true if they were at an infinite distance apart, but appreciable errors come in when the distance between them is less than a hundred times the radius of either. It is easy to show that the magnetic conductance between two spherical poles equals 4π times the electrostatic capacity between their surfaces. Hence, as the electrostatic capacities have been tabulated, the magnetic conductances could be written down at once with high accuracy. From the engineering point of view the paper is valuable, as the subject is of practical importance to manufacturers.

PROF. W. W. WATTS, lecturing to the South Kensington Branch of the National Union of Scientific Workers on May 27 on "The Evolution of the Bicycle," showed that the development of this, as of any mechanical apparatus, took a similar course to that observed in biological evolution. It was largely a process of trial and error; advance was usually in small details of specialisation, and, as in the case of the high bicycle, development was apt to take place in a "blind lead" by following out a wrong principle. The lecture will be reported in the next issue of the *Scientific Worker*, copies of which can be obtained from the Secretary, N.U.S.W., 19 Tothill Street, S.W.1, by sending a stamped addressed envelope.

KODAK, LTD. (Wratten division), have just issued a new series of nine circular light-filters to facilitate visual work with the microscope. They are 35 mm. in diameter, and so fit the standard turn-out ring usually available in sub-stage fittings. Six are for increasing the contrast in stained or coloured preparations, one is blue and serves for getting the highest resolving power, one a neutral tint for modulating the intensity of the illumination, and the ninth converts the light from metal filament vacuum lamps into the equivalent daylight. This last is also of service with other light sources, such as the new thorium pastille gas lamp and the usual paraffin lamps. Its use gives the same colour values as daylight, and so reduces or eliminates eye-strain when observations are long continued.

IN a small leaflet entitled "Radium Facts," received from Messrs. Watson and Sons, are collected numerous data relating to radio-active substances useful to intending purchasers. From it we learn that, whereas the total production of radium to date by the Standard Chemical Co., of Pittsburgh, was 50 grams of radium element, its present output is at the rate of 18 grams of the element per annum. We understand that this output could be increased to 50 grams of radium element yearly if the demand for such a quantity should arise—a very considerable national asset. It is interesting to observe that the present total available supply of high-grade purity radium in the world is estimated to be about 120 grams.

Our Astronomical Column.

RETURN OF TEMPEL'S COMET.—Tempel's second periodic comet, discovered in 1873, was detected by Mr. Kudara at Kyoto, Japan, on May 25d. 7h. 10m. G.M.T., in R.A. 20h. 55m. 7s., S. decl. 4° 53′. The approximate time of perihelion passage is 1920 July 10·36. The other elements are approximately as follows:—ω 186° 38′ 43″, Ω 120° 37′ 59″, i 12° 45′ 17″, ϕ 33° 54′ 21″, μ 685·881″. The following ephemeris has been computed for midnight:

		R.A.	S. Decl.	Log r	Log Δ
		h. m. s.	° ′		
June	4 ...	21 28 0	4 34	0·1402	9·8077
	12 ...	21 54 28	4 41	0·1330	9·7739
	20 ...	22 21 44	5 7	0·1274	9·7440
	28 ...	22 48 40	5 58	0·1236	9·7166
July	6 ...	23 15 20	7 15	0·1216	9·6950

The comet is probably faint, but as it is approaching both sun and earth its brightness should increase perceptibly. It rises half an hour before midnight, and is fairly well placed for observation just before dawn.

DOUBLE STARS.—Since its erection in 1894, the 28-in. equatorial at Greenwich has been mainly used for the observation of double stars; the list included many of special difficulty owing to faintness or close proximity. Mr. J. Jackson has discussed the observations made at Greenwich and elsewhere in Monthly Notices for March, and publishes twenty revised orbits. One of the stars is Struve 2525, for which very discordant values of the period have been found. The new value, 354·9 years, is larger than those previously found, which range from 138 to 307 years. The semi-axis major is 1·1″ and the eccentricity 0·93, so that at the time of periastron, 1887·3, the star could not be separated.

The star Struve 2055 had given much trouble to computers; two observations by Sir William Herschel in 1783 and 1802 were mutually inconsistent. Mr. Jackson has unearthed a note that the micrometer reading was not written down at the time, and that the reading entered may be wrong. The quadrant noted is shown to have been correct, and Herschel's other observation in 1802 is well satisfied. The period assigned is 110 years and the eccentricity 0·86.

With respect to notation, he directs attention to diversity in the method of reckoning the angle ω, and recommends the general adoption of the system used by Campbell, Aitken, and Hussey, in which it is measured in the direction of motion in the orbit plane.

DIFFRACTION IMAGE OF A DISC.—Mr. H. Nagaoka contributes a useful article on this subject to the *Astrophysical Journal* for March. Diagrams of the "isophotes" are given, and it is shown that the results explain the black drop observed in transits of Venus, and the projection of bright stars upon the moon's disc that has often been observed in occultations at the illuminated limb. A striking case of this phenomenon has lately been noted in the reappearance of the star Leipzig I 4091 from behind Saturn on March 22 last. Messrs. Reid, Dutton, and McIntyre, observing in South Africa, saw the star reappear within the limb of the planet, its conspicuous orange colour facilitating its detection. They give the explanation that the outer portion of Saturn is composed of transparent clouds, but it would seem that the expansion of the disc by diffraction is sufficient to account for it. (B.A.A. Journal, April.)

It is of interest to note that in South Africa the star at disappearance passed behind the ring, while in Europe, owing to parallax, it did not. It was clearly visible through the ring, showing that the separate particles composing the ring are not very densely massed.

Monument to Charles Gerhardt.

NOW that Alsace is once more united to France, it is peculiarly fitting that Strasbourg, his native place and where he lies buried, should be the site of the long-delayed monument it is proposed to erect to the memory of Charles Gerhardt. British chemists who are at all familiar with the history of their science scarcely need to be reminded of the part played by Gerhardt in its development, or of the influence which his writings exercised in the search for methods of elucidating the structure and constitution of chemical compounds.

His "Traité de Chimie organique" may be said to mark an epoch; it was a significant feature of a movement which characterises the middle of the nineteenth century, and which the book itself greatly accelerated. Although much of its teaching, as the systematised expression of the facts of organic chemistry, is obsolete, the work is, and will remain, a classic, for it forms the basis upon which the superstructure of modern chemistry is erected. Gerhardt, however, was not only a speculative philosopher of the highest type; he was also an experimentalist of uncommon power and insight who framed his theoretical conceptions in the light of his own ascertained facts, and tested them by further investigations designed either to substantiate or to disprove them. His name is associated with the discovery of many new substances, some of which, like the acid anhydrides, are of the greatest theoretical and practical importance. It may be claimed for him that, together with Dalton and Berzelius, he was one of the principal founders of the atomic theory and the originator of the notation which immediately flows from it.

An influential committee has now been formed to discharge the debt—long overdue—which the chemical world owes to Gerhardt's memory. It comprises the names of some of the most eminent of French men of science and of those of Allied countries, under the presidency of M. Armand Gautier, member of the Institute, with an executive consisting of M. Haller, member of the Institute, as chairman; M. Chenal, treasurer of the French Chemical Society, as treasurer; and M. Tiffeneau, assistant professor of the Faculty of Medicine, as secretary. The object is well worthy of the consideration of British chemists, and may be specially commended to the notice of the Chemical Society and the Society of Chemical Industry if these bodies have not already responded to the appeal.[1]

T. E. THORPE.

Biological Papers from Bengal.

THE publications of the Asiatic Society of Bengal during the years 1916 to 1919, which we have lately received for review, contain a large number of contributions to biology, showing an activity in this department that has not been surpassed before. If we consider also the publications issued by the Indian Museum, the Calcutta Botanic Gardens, and the flourishing Bombay Natural History Society, we have reason to rejoice over the prosperous state of this branch of knowledge in our Indian Empire. Allusion should be made also to the enterprise of Dr. N. Annandale, who, alone or with other members of the Zoological Survey of India, of which he is the director, has in the last seven years investigated the

[1] A circular signed by Sir James J. Dobbie, president of theChemical Society, has just been issued inviting fellows of the society to contribute to the memorial fund. Such contributions should be sent to the Treasurer, Chemical Society, Burlington House, London, W.1.—ED. NATURE.

macroscopic fauna of various Asiatic lakes, with results that are of the greatest interest.

The Asiatic Society of Bengal issues Memoirs in quarto, and Journal and Proceedings in octavo. In the Memoirs, parts ii. to v. of Dr. Annandale's "Zoological Results of a Tour in the Far East" further testify to the author's wonderful activity and versatility, which are known to all zoologists. In these parts he deals himself with the Hydrozoa and Ctenophora, the Batrachia, the Sponges, and the Mollusca, together with additions to ethnography; whilst other groups have been entrusted to C. A. Paiva (aquatic Hemiptera), Col. J. Stephenson (aquatic Oligochæta), Dr. Asajiro Oka (Hirudinea), Sir Charles Eliot (Mollusca Nudibranchiata), Tokŏi Kaburaki (brackish-water Polyclads), and Stanley Kemp (Crustacea Decapoda and Stomatopoda). Numerous text-figures and five plates illustrate these contributions.

Dr. Annandale's paper on the Hydrozoa and Ctenophora is one of special interest, our knowledge of the Oriental fresh-water forms of these two groups being of rather recent date and, as the author observes, still very imperfect. A new Medusa is described under the name of *Asenathia piscatoris*, g. et sp. nn., from the tidal creeks containing water of low but extremely variable salinity in the vicinity of Port Canning, in the Gangetic Delta. It is referred to the family Olindiadidæ of Mayer (order Trachymedusæ), and is regarded as not improbably the sexual generation of the hydroid *Annulella gemmata*, Ritchie.

In the part devoted to the Batrachians, Dr. Annandale deals chiefly with the Oriental frogs of the groups of *Rana tigrina*, *R. limnocharis*, and *R. Liebigii*, as well as with the species clustering round *R. Tytleri* and *R. erythraea*; also with various tadpoles from Japan, China, the Malay Peninsula, Burma, and Ceylon. The author's views on *R. tigrina* have since been a subject of discussion between him and Mr. Boulenger in the Records of the Indian Museum, and further differences of opinion between the two authorities will shortly appear in a monograph of the Oriental species of Rana to be published by the Indian Museum.

The two marine Sponges (*Reniera implexa*, Schmidt, and *Amorphinopsis excavans*, Carter, var. n. *Robinsonii*) discussed by Dr. Annandale were found growing on the wooden piers of a landing-stage at Port Weld in Perak, Malay Peninsula, and their chief ethological interest lies in the fact that they grew immediately below high-tide level, and were, therefore, exposed daily for a considerable time to the air and to the heat of a tropical sun. Several new fresh-water Sponges from Japan, China, and the Malay Peninsula are described, and a list of the Spongillidæ of Asia, with synonyms, is appended.

Among the Mollusca the hybrid name Pseudovivipara for a new genus is a regrettable choice.

A paper in French is a revision of the fungi of the genus Nocandia, Toni and Trevisan, by Capt. Froilano de Mello and Dr. St. Antonio Fernandez, of the Portuguese India Bacteriological Service.

The Memoirs contain also a revision of the lizards of the genus Tachydromus, with two plates, by Mr. G. A. Boulenger, in which this genus is shown to be very closely connected with Lacerta, instead of occupying a quite isolated position in the family to which it belongs, as hitherto believed. Two new genera are proposed under the names of Platyplacopus and Apeltonotus.

In the Journal and Proceedings we have a paper by Baini Parshad on the seasonal conditions governing the pond-life in the Punjab. There are three papers on Mollusca: two by E. Vredenburg on the occurrence of *Cypraea nivosa* in the Mergui Archipelago, the only previously recorded habitat of this species being Mauritius, and of *Dolium variegatum* at Mascat and Karachi, a species hitherto regarded as special to the living fauna of Australia, but recorded from the Pliocene of Java; and one by Dr. Annandale and B. Parshad on the taxonomic position of the genus Camptoceras and of *Lithotis japonica*. W. H. Phelps describes the weaving habits of the spider *Cyrtophora citricola*, and Maude L. Cleghorn has experiments on the vitality and longevity of silkworm moths during the cold and rainy seasons in Bengal.

Botany is represented by four contributions: Notes on the flora of the Anaimaly Hills, by C. Fisher; on the pollination of flowers, by I. K. Burkill; on the Burmese sesamum varieties, their variation and growth, by A. McKerral; observations and experiments on the rust of *Launaea asplenifolia*, commonly known as Jangli Gobi, by Karm Chand Mehta; and on the constituents of the bark of *Hymenodactyon excelsum*, by C. L. Gibson and J. L. Simonsen.

Attainment of High Levels in the Atmosphere.

SCIENCE for March 19 has an article by Prof. Alexander McAdie, of Blue Hill Observatory, on "The Attainment of High Levels in the Atmosphere." A period of 135 years is dealt with, during which various methods and agencies have been employed for exploring the high levels of the atmosphere. Dr. John Jeffries crossed the English Channel in January, 1785, and attained a height of about 2012 metres, and in the following twenty years heights of more than 4000 metres were attained. In September, 1862, Glaisher and Coxwell reached a height of 11,200 metres. Three other noteworthy records by manned balloons are mentioned. Tissandier, Spinetti, and Sivel, acting for the French Academy, attained a height of 8530 metres in April, 1875; Dr. A. Berson reached 9600 metres in December, 1894; and Berson and Süring in 1901 attained a known elevation of 10,500 metres, and probably 10,800 metres, both men being unconscious at the higher level. Dealing with other than manned balloons, the extreme elevations noted are:—By kites, 7044 metres in 1907; by rigid dirigibles, 6200 metres in 1917; by sounding balloons, 37,000 metres in 1912; and by pilot balloons, height determined by theodolite, 39,000 metres. The aeroplane record has rapidly advanced. In 1909 Latham made 161 metres, and Drexel in 1910 made 1829 metres. Prior to 1914 the maximum height attained, according to Prof. McAdie, was 6000 metres by Perreyon in March, 1913. The war gave a great impetus to the development of the aeroplane, and since the war, in February, 1920, Major R. W. Schroeder, chief test pilot at Dayton, U.S.A., is stated to have attained 10,979 metres; in this ascent the oxygen-supply was exhausted. The 10-km. level is the bottom of the stratosphere or isothermal region, and the top of the troposphere or convectional region—an exceedingly important elevation to meteorologists. Schroeder's thermograph indicated a minimum temperature of −55° C., or 99° below the freezing point on the Fahrenheit scale.

In *Science* for April 9 Dr. J. G. Coffin, director of aeronautical research of the Curtiss Aeronautical and Motor Corporation, suggests that Prof. A. McAdie has sometimes accepted too readily unauthorised statements made in the Press as to altitudes reached. A criticism is made of expressing results without air-temperature correction, which is not only unsatisfactory, but also scientifically incorrect. The correction is the larger the colder the air encountered in the flight. It is pointed out that it is essential so far as possible for all concerned to work on the same un-

biased scientific basis. Dr. Coffin, to bring out the importance of the air-temperature correction, assumes two cases, both with identically perfect barographs, with no instrumental errors, one ascent in summer and the other in winter to an altitude that both read 8 in. of mercury as the minimum pressure. He assumes that in the summer case the average temperature of the air is 10° C., and in the winter −30° C., which values correspond closely to actually observed figures. The true altitudes of these are 33,475 ft. (10,203 m.) for the summer instance and 30,929 ft. (9427 m.) for the winter, although the altitude uncorrected for air temperature is 36,020 ft. (10,979 m.) for both. Dr. Coffin states that the flight made by Roland Rohlfs, the test pilot of the Curtiss Engineering Corporation, on September 18, 1919, attained an altitude of 34,910 ft. (10,640 m.), partially corrected, but uncorrected for the average temperature of the air column; the true altitude was 32,450 ft. (9890 m.) corrected for air temperature. The altitude attained by Major Schroeder, similarly corrected for temperature, is 30,751 ft. (9373 m.).

In *Science* of April 30, Prof. McAdie gives as approximate values, corrected for mean air column temperature, vapour pressure, gravity, altitude, and latitude: Rohlfs, 32,418 ft. (9880·5 m.), and Schroeder, 31,184 ft. (9505 m.).

The *Meteorological Magazine* for March, in an article "The Highest Aeroplane Ascent," mentions Major Schroeder's ascent on February 27 last referred to above, and expresses the hope that it will be authenticated in due course. The record of Berson and Süring, who, it is stated, reached 35,400 ft. (10,789 m.) in a balloon on July 31, 1901, is mentioned as being generally accepted as the greatest height hitherto attained by aeronauts. The article seems to throw some doubt on the lowest temperature observed in the ascent by Glaisher and Coxwell.

Physical Problems in Soil Cultivation.[1]

UP to the outbreak of the war the farmer could generally rely upon an adequate supply of cheap labour. He had no great necessity to introduce labour-saving machinery into the routine of the farm. But the increasing demands of the Army for men and the menace of the submarine campaign brought him face to face with the difficult problem of growing more food with a greatly reduced staff. In such conditions the employment of machinery was the only solution, and although at the time it was introduced mainly as a temporary measure, it is now quite evident that economic conditions will cause it to be retained permanently. During the war the rate of progress in the industry of agriculture was necessarily forced above the normal, and the urgent need at the present time is to take stock of the position, so that future developments may be guided along the right lines. In this connection the report of the Departmental Committee of the Ministry of Agriculture on Agricultural Machinery appears at an opportune moment. The report deals with "the further steps which should be taken to promote the development of agricultural machinery," and, so far as tillage implements are concerned, falls naturally into two sections, dealing with (1) fundamental research on the physical properties of soil as affected by cultivation operations, and (2) the application of the knowledge thus gained to the design of new implements and the improvement of old ones.

[1] Report of the Departmental Committee of the Ministry of Agriculture on Agricultural Machinery. (H.M. Stationery Office.) Price 1s. net.

Taking the second section first, the Committee lays great stress on the fact that all development in the design of machinery has proceeded on empirical lines. "Although searching questions were addressed to several witnesses, we could not discover that any real attempt had been made in the past to determine the principles which underlie the design of the variety of implements in use in modern farming." As a result an enormous number of patterns of the same implement are made, one manufacturer alone having more than two hundred and fifty patterns of plough. The Committee considers that much of this overlapping and wasted effort will be avoided when the Ministry of Agriculture sets up its projected Research Institute in Agricultural Machinery.

The first section—research into the physical properties of soil—is regarded, rightly, as of primary importance. "Progress in research as regards tillage implements must depend largely upon the results of investigations into soil physics and the problem of tilth." It is clearly pointed out that this research must not be pursued with the immediate object of obtaining "practical" results. A sound theory of the interesting but complicated physical phenomena shown by soil must first be built up. Once this is achieved, the practical deductions will follow almost automatically. The very nature of this work precludes the possibility of forcing the pace, but it is suggested that, as the work has been in progress for some time at Rothamsted, it should be further developed by the appointment of additional scientific assistants.

If this were done it would be possible to pay more attention to those physical problems concerned with the soil tilth than is practicable at present. Tilth is related to the production of compound particles or aggregates in the soil, and to the factors causing plasticity, cohesion, etc. At the same time a study of the mechanical action of the plough could be started having as its aim the specification of the design of mould-board to meet different soil conditions. This is an unsurveyed field and full of promise.

The report also deals with the educational and research work which should be carried out at the projected Research Institute in Agricultural Machinery, especially from the engineering point of view. It also advocates the appointment of an Advisory Committee, composed of representatives from the research institutions, implement-makers, and agriculturists, to co-ordinate the whole of the work.

In the present article attention has been confined mainly to the sections dealing with the physical questions involved. The report covers a much wider field. It is closely reasoned and convincing, and can be cordially recommended to all concerned in the industry of agriculture.

B. A. KEEN.

The Anomaly of the Nickel Iron Alloys: Its Causes and its Applications.[1]

THE lecturer began by a reference to the work of John Hopkinson, and to his own early work on the perfecting of standards of length. His first experiments were on nickel, which had two great advantages over brass for metrological work, viz. its smaller coefficient of expansion and its greater freedom from corrosion. He would probably not have looked further but for the difficulty at the time of getting large bars of the material free from flaws. In investigating the

[1] Abstract of the Fourth Guthrie Lecture delivered before the Physical Society on April 23 by Dr. C. E. Guillaume.

ferro-nickel alloys, his first experiments were on their magnetic properties, as these were easier to investigate than the coefficients of expansion. Dr. Guillaume showed and explained curves representing the variation of magnetic properties, and of the coefficients α and β in the expansion equation $l = l_0(1+\alpha\theta+\beta\theta^2)$ for alloys in both the irreversible and reversible categories, and showed from the curves how it was possible to obtain alloys with any desired coefficient. The anomalous magnetic behaviour of some of the alloys was illustrated by demonstration experiments of the effect produced on the magnetic condition of bars of the materials by dipping in hot water or liquid air. The lecturer then dealt with the properties of ternary alloys containing iron, nickel, and a third element. Manganese alloys were those most extensively used. He exhibited a cardboard model of Guthrie's three-dimensional diagram for ternary alloys. The addition of the third element raised the minimum expansion. In the case of carbon and chromium the elastic constant is raised. The curve connecting Young's modulus with the percentage of nickel in ferro-nickel alloys also showed an anomaly in the same region as the expansion.

The chief weakness of the alloys from the point of view of the metrologist was instability. If a piece of invar was cooled from a high temperature in air at 100° C. its length reached a steady value in about 100 hours. If it was then cooled to 50° C. its length would increase to another steady value, reached in about 1000 hours or so. If it were then cooled to zero it would still further lengthen, a steady state not being reached for a very long time. If the temperature were then raised again to 100°, the length would diminish to its initial value for 100°. The total change of this character between 0° and 100° amounted to about 30 millionths of the length.

With increasing carbon content the instability very rapidly increased. It was possible from the amount of the instability to estimate the carbon to 1/100th per cent. Moreover, the curve connecting the instability and the carbon content passed through zero, showing that the instability was due to the carbon. It was therefore possible to get an invar of perfect stability.

Among the applications to which invar had been put, the lecturer instanced pendulum rods, leading in wires for electric lamps (an alloy being chosen from the curves so as to have the required coefficient of expansion), wire standards for base measurements in surveying, etc., and showed curves of the variation of height of the Eiffel Tower with temperature, as measured relatively to invar wires.

Another important application of these alloys was in chronometer construction. The temperature coefficient of the rate of a watch was due to variation of the elasticity of the hair-spring. This was corrected in the Graham compensation by a variation of angular momentum of the balance wheel, depending on the difference in expansion of two metals; but it was possible to choose for the spring a nickel steel having a temperature coefficient of elasticity nearly zero. If chosen to give the same rate at 0° and 30°, there would be a secondary error of only 20 seconds per day at 15°. But a more important chronometric application was the correction of the secondary error of 2 seconds in Graham's compensation. This error, discovered by Dent in 1832, is due to the fact that the variation of elasticity of the hair-spring is not a linear function of the temperature, whereas the variation of angular momentum of the balance wheel is. If, however, for one component of the bimetallic compensator a nickel steel of negative β be chosen, it is possible to get a curve connecting the momentum with temperature which exactly compensates the elasticity variation over the whole range.

Reverting to the curves for Young's modulus, the lecturer predicted that an alloy would shortly be produced having a practically constant modulus over a range of 200° C.

Technical Education and Mind Training.

THE proceedings of the annual conference of the Association of Teachers in Technical Institutions, which was held in the Polytechnic, Regent Street, London, on Whit-Monday, were full of interest. The president, Mr. E. L. Rhead, of Manchester, gave a stimulating address, in the course of which he reviewed unfavourably the attitude of the Workers' Educational Association towards technical education as tending to narrow the workers' educational outlook, and as merely serving to create a human tool better calculated to promote the interests of employers and the sordid aims of industry. He claimed, on the contrary, that, rightly presented, technical education has in it all the elements of mind training and of a wide view of life and its problems. It may, in short, be, properly interpreted, constituted as the pivot of a liberal education. He deprecated the exclusive devotion of much of modern higher education to dead languages, dead history, and ancient philosophy, but that is surely to ignore a prime element in the evolution of mankind—the progress of man in his endeavour to search into and to solve the phenomena of Nature. Mr. Rhead went on to consider the status of the technical teacher as compared with that of the secondary-school teacher, and contended that the former should be at least as liberally considered as the latter, not only by reason of his long and arduous practical training in the processes of industry, but also in respect of the claims of industry itself upon his services. He urged the desirability of transfer from lower to higher schools at different periods in the course of the educational life of the capable pupil, and especially dwelt upon the value of the junior technical school, which he would in no wise desire to convert into a trades school, and pleaded that restrictions on their present aims and curricula should be removed. A far more liberal system of scholarships, including maintenance, should be established in co-operation with widely extended administrative educational areas, which should have regard not only to the pupils in day institutions, but also to the equally urgent requirements of the promising evening students, enabling them to devote themselves to whole-time study in their special vocation. There should likewise be an efficient representation of teachers on all education authorities, so that the present and future problems of technical education should be better considered. Resolutions were passed urging a large increase in salaries for the several grades of technical teachers; that all works continuation schools should ultimately be provided by the local education authorities and the present schools be open to inspection by the local and central authorities; and that a national Whitley council for teachers should be set up.

University and Educational Intelligence.

CAMBRIDGE.—Prof. J. T. Wilson, professor of anatomy in the University of Sydney, has been elected to the chair of anatomy rendered vacant by the death of Prof. A. Macalister.

We are informed by the secretary of the Cambridge Philosophical Society that the adjudicators of

the Hopkins prize have made the following awards:—For the period 1903–6 to Dr. W. Burnside, of Pembroke College, for investigations in mathematical science; for the period 1906–9 to Prof. G. H. Bryan, of Peterhouse, for investigations in mathematical physics, including aerodynamic stability; and for the period 1909–12 to Mr. C. T. R. Wilson, of Sidney Sussex College, for investigations in physics, including the paths of radio-active particles.

Dr. T. G. Adami, Vice-Chancellor of the University of Liverpool, has been elected to an honorary fellowship at Christ's College.

An offer of 30,000*l.* has been made to the University by the Committee of Council for Scientific and Industrial Research for the erection, equipment, and maintenance at Cambridge of a low-temperature station for research in biochemistry and biophysics. The proposal emanates from the Research Board of the Department charged with the co-ordination of researches related to the scientific problems arising out of the preservation and handling of food. It is desired to erect the new station close to the existing biological laboratories, where a large proportion of the researches initiated by the Board have been carried out. It is proposed to vest the management of the station in a committee of the Senate containing some members nominated by the Department of Scientific and Industrial Research. The director of the station would be appointed by the Lord President of the Council after consideration of a report by the committee.

LIVERPOOL.—A Congregation of the University was held in St. George's Hall on Friday, May 28, when honorary degrees were conferred. Mr. J. W. Alsop, Pro-Chancellor of the University and chairman of the Liverpool Education Committee; Sir Alfred Booth, chairman of the Cunard Steamship Line; Sir Alfred Dale, the former Vice-Chancellor of the University; Mr. John Rankin, a leading citizen and merchant of Liverpool; and Sir Michael Sadler, Vice-Chancellor of the University of Leeds, received the degree of Doctor of Laws. Sir Reginald Blomfield, a member of the Royal Academy and past-president of the Royal Institute of British Architects, and Mr. Frederick Powicke, professor of medieval history in the University of Manchester, received the degree of Doctor of Letters. The degree of Doctor of Science was conferred on Prof. F. G. Donnan, formerly professor of physical chemistry in the University, and now professor of chemistry in University College, London, and on Prof. W. A. Herdman, formerly Derby professor of natural history, and now professor of oceanography, in the University. Mr. Henry Martin, chairman of the St. Helens Higher Education Committee, and representative of the borough on the Court of the University, and Father Thomas J. Walshe, a distinguished scholar, and formerly chaplain and lecturer at the Notre Dame College in Liverpool, were given the degree of Master of Arts. Mr. Joseph Gibson, a leading engineer and president of the Liverpool Engineering Society, received the degree of Master of Engineering.

LONDON.—Two lectures, entitled "Emploi des métaux ammoniums en Chimie Organique" and "L'Œuvre Scientifique d'Henri Moissan," will be given at King's College, Strand, W.C., by Prof. P. Lebeau, professeur à l'Ecole Supérieure de Pharmacie, Université de Paris, at 5 p.m. on Monday, June 28, and Wednesday, June 30. The lectures, which will be delivered in French, are addressed to advanced students of the University and to others interested in the subject. Admission is free, without ticket.

OXFORD.—The honorary degree of Doctor of Letters has been conferred on Dr. Temistocle Zammit, professor of chemistry in the University of Malta and curator of the Valetta Museum.

It was resolved by Convocation on June 1 to confer the title of professor on Dr. T. R. Merton, Balliol College, so long as he continues to hold the office of reader in spectroscopy.

ST. ANDREWS.—The Senatus Academicus will confer the following honorary degrees at the public graduation ceremonial to be held on July 2:—*LL.D.*: Sir Dugald Clerk; Dr. Léon Frédericq, for nearly forty years professor of pathology in the University of Liége, Belgium; Mr. R. A. Herman, fellow and lecturer of Trinity College, Cambridge; Mr. W. J. Matheson, New York, U.S.A.; Dr. N. K. Smith, professor of logic and metaphysics in the University of Edinburgh; and Dr. N. Walker, his Majesty's Inspector of Anatomy for Scotland.

THE medal of honour of the University of Brussels was presented by the Vice-Chancellor on May 22 to Lord Dawson of Penn, Sir Leslie Mackenzie, and Prof. Sir William Smith.

PROF. E. F. NICHOLS has resigned the chair of physics held by him at Yale University to take up the post of director of pure science in the Nela Research Laboratories of the National Lamp Works of the General Electric Co. at Cleveland, Ohio.

IN connection with the London County Council's lectures for teachers on recent developments in science, a lecture on "The World-Problem of Nitrogen" will be given by Prof. F. G. Donnan at University College, Gower Street, W.C.1, on Monday next, June 7, at 6 p.m. The chair will be taken by Lord Moulton.

A PUBLIC meeting in support of the claim of the Imperial College of Science and Technology for degree-conferring power and university status will be held at the Central Hall, Westminster, to-morrow, June 4, at 5 p.m. Lord Morris will preside, and will be supported by Sir Arthur Acland, Bart., Sir Alfred Keogh, Col. Sir Pierre van Ryneveld, Mr. H. G. Wells, Mr. J. A. Spender, and others.

THE foundation-stone of the new wing of the London School of Economics was laid by the King on Saturday last, May 29. His Majesty was accompanied by the Queen and Princess Mary, and the Royal party was received by Dr. Russell Wells, Vice-Chancellor of the University of London. In an address Dr. Wells referred to the meeting held at the Mansion House in 1918, when it was determined to institute London degrees in commerce, and to collect funds in order to found and endow in the University what it is hoped would ultimately become the greatest school of commerce in the world. As a result of the response to the appeal of the University by the bankers, shippers, and merchants of London, and the substantial contribution of Sir Ernest Cassel, through the Cassel Trustees, the sum of more than 300,000*l.* was obtained towards the founding and endowing of the scheme for commercial education. In the course of his reply the King said:—"I am fully sensible of the patriotic work which has been accomplished by the universities during the war, of their instinctive and immediate response to the call of duty, of their heavy burden of sorrow and loss, of their varied and brilliant contributions to the science of modern warfare, and of the extent to which their normal activities have been suspended or deflected by five years of national peril. It is for this reason the more gratifying to me to note that the University of London, which has grudged nothing of its youth and valour to our armies in the field, has been planning the development of

new spheres of usefulness in the furtherance of the fruitful arts of peace. Three centuries ago Francis Bacon censured the universities of his own age as the homes of ignorant dogma and sterile disputation. The bad and narrow tradition which was then attacked has long since disappeared, and the circle of academic studies has been steadily enlarged by the pressure of scientific ideas and of practical needs without injury to the claims of a broad and humane education. When estate management, horticulture, and commerce are included in the curriculum, a university can no longer be described as a place in which nothing useful is taught. It is right and fitting that the new faculty of commerce should be linked to the London School of Economics, which has for many years enjoyed the reputation of being one of the principal centres of economic inquiry in my Empire, and I regard it as no less appropriate that a university situated at the very heart of our commercial system should now resolve to turn the dispassionate and illuminating eye of science upon the facts and principles of commercial life."

Societies and Academies.

LONDON.

Royal Society, May 20.—Sir J. J. Thomson, president, in the chair.—Prof. J. N. **Collie**: Some notes on krypton and xenon. In the paper the measurements of a considerable number of new spectroscopic lines at the red end of the spectrum are given; also a curious property of xenon has been noted. In tubes containing xenon, when a strong current from an induction coil is passed, much splashing of the electrodes occurs, and the xenon disappears as a gas. What becomes of the xenon is not clear, as it does not seem to be liberated again, either by strongly heating the metallic splash or by dissolving up the splash in suitable solvents.—Sih **Ling Ting**: Experiments on electron emission from hot bodies. Experiments on the electron currents from a platinum disc in a uniform field made by Prof. Richardson in 1907–9 showed that under the conditions of these experiments the distribution of velocity among the emitted electrons was very close to the requirements of Maxwell's law for a gas of equal molecular weight and temperature, but it was noted at the time that rough tests made on the liquid alloy of sodium and potassium, on platinum coated with lime, and on platinum saturated with hydrogen indicated an exceptional behaviour. The further investigation of these substances was postponed owing to technical difficulties and to the pressure of other problems. In 1914 Schottky investigated the electrons emitted from tungsten and carbon, and found a distribution of energy in close accordance with Maxwell's law, except that the mean energy varied between 2 per cent. and 25 per cent. in excess of that calculated from the filament temperatures. Errors in the estimation of these temperatures and in other directions might, however, have accounted for these discrepancies. The present experiments show that deviations from Maxwell's law, if not general, are at any rate quite common. With tungsten and platinum in a well-exhausted enclosure a common distribution is one which satisfies the requirements of Maxwell's law, except that the average electron energy is in excess of (frequently about twice as great as) that corresponding to the temperature of the source. Other cases have been recorded in which the velocity distribution has a different functional form.—L. **Silberstein**: The aspherical nucleus theory applied to the Balmer series of hydrogen. The general formulæ for spectrum emission by atomic systems containing an aspherical nucleus, given by the author in a previous paper (*Phil. Mag.*, vol. xxxix., p. 76), are now applied to hydrogen atoms the nuclei of which are treated as axially symmetrical charged distributions. The asphericity and the value of the Rydberg factor are determined from Mr. Curtis's observations of Hα up to Hγ. The series formula thus resulting (and containing but two constants) is shown to agree well with the six observations. The value of the asphericity coefficient is then used to determine the fine structure of the members or groups of the Balmer series, more especially of the groups Hα and Hβ, which are discussed in some detail.—T. E. **Stanton**, Miss D. **Marshall**, and Mrs. C. N. **Bryant**: The conditions at the boundary of a fluid in turbulent motion. Observations were made on air flowing through long pipes of circular cross-section at mean rates of flow covering as wide a range as possible below and above the critical speed. Dimensions of pipes used were 0·269, 0·714, and 12·7 cm. in diameter. Range in experimental conditions varied from $vd/\nu=460$ to $vd/\nu=325{,}000$, where v is mean speed of flow, d diameter of pipe, and ν kinematic viscosity of air. Estimation of velocity of fluid in neighbourhood of boundary was made from observations of difference in pressure existing in a small Pitot tube facing the direction of flow, and that in a hole in the wall of the pipe. The Pitot was of rectangular section, external dimensions at orifice being 0·1×0·8 mm. and internal dimensions 0·05×0·75 mm. By this means observations could be made up to a distance of 0·05 mm. from the wall. For distances less than this, by a special device the wall of the Pitot nearest the wall of the pipe was cut away and its place taken by the wall of the pipe. By this means observations could be taken at a distance of 0·01 mm. from the walls. From a comparison of the curves of velocity distribution near the boundary, obtained from observations with the Pitot and the composite tube, it was found that in the case of the former the interference with the flow near the orifice by side of tube adjacent to boundary was considerable. Velocity curves obtained from the composite tube, when further corrected for interference, were found to tend to a definite slope at boundary, which was identical with that which would exist in a layer of fluid in laminar motion and having the same surface friction as that actually measured.

Linnean Society, May 6.—Dr. A. Smith Woodward, president, in the chair.—Dr. G. P. **Bidder**: Sponges. (1) The fragrance of calcinean sponges. Clathrinidæ have a noticeable aromatic scent, probably due to the excretory granules which give their bright colours. These granules especially surround the pores. May this be to attract the spermatozoa? The author has not seen the fine-lashed spermatozoa of Poléjaeff, but in Sycon has observed a stiff-tailed organism—possibly the result of curious gregarine-like objects produced in cells resembling gonocytes. (2) *Syncrypta spongiarum* (wrongly assigned to Pandorina in his MS.) the author gives as a name to the "alga" abovementioned. He suggests that it is a dangerous parasite, against which *Grantia compressa* has a successful phagocytosis, but that certain other sponges are hosts for its Palmella stage. (3) Notes on the physiology of sponges. (*a*) Cercids, proposed as a name for the "minute wandering cells." (*b*) Cessation of the current in sponges. (*c*) Differences between Calcinea and Calcaronea in their porocytal granules and odour. (*d*) The excreta of collar-cells are gelatinous globules containing dark particles. Probably Dendy is right in comparing these to the "spermatozoon-heads" of Poléjaeff, which may be the ultimate residue of victorious

phagocytosis. (*e*) Origin of sponges. Archæocytes may have been differentiated into external excretory cells and internal reproductive cells; the former engulfed cercids, but only to pass them on to the latter. By abbreviation of this process the excretory cells may have become self-perforating porocytes, which were then adapted to supply water to flagellate cells in the centre of a Protospongia-like colony, thus converting it into an elementary Olynthus.

Royal Meteorological Society, May 19.—Mr. R. H. Hooker, president, in the chair.—Dr. Griffith **Taylor**: Agricultural climatology of Australia. The author, after indicating briefly the diversity of climates in Australia, pointed out the extreme importance of the rainfall, more so than in most other countries, as the controlling factor in the settlement of the country; also that the season at which rain falls and the certainty of its occurrence (its "reliability") were as important as the total amount. The greater proportion of the wheat-lands lay in regions receiving less than 20 in. of rain per annum, while the crop can be grown with as little as 7 in. if it falls at the right time. Sugar-cane is confined to the eastern coast, where the rainfall exceeds 40 in. and the temperature 68° F. The hay crop is also important, and in dry seasons when the grain fails includes a large bulk of cereals. Ninety per cent. of the sheep are in the south-eastern third of the continent; a rainfall of at least 10 in. and a temperature below 77° are required for them. Cattle are reared more in the north-east. The great variability of the rainfall frequency results in serious droughts and consequent failure of the cereal crops and reduction of flocks and herds; but it is hoped that these recurrent losses will become less serious in time with the progress of irrigation, though Dr. Taylor is not sanguine that irrigation will open up to settlement the enormous areas that seem to be anticipated by some writers.—J. E. **Clark** and H. B. **Adames**: Report on the phenological observations for the year 1919. The dominant factors in 1919 were the excessive wetness until April and drought in May and early June, lasting or reappearing until October or later. The abnormally warm December of 1918 was followed by four months universally cold, closing with heavy snow in the last week of April. Then hot summer weather in May and early June preceded a detrimental six weeks or more of abnormal cold. Cold recurred after August, culminating in a November deficiency beyond most records. In consequence, summer-growing garden crops (such as celery and cauliflower) were poor and most field crops short, though fairly good, especially potatoes. Of tree-fruits only plums and apples cropped heavily, the latter ripening and colouring to a degree rarely known, and excelled only by the wonderful autumn tints—both, no doubt, due to the dry and sunny autumn. As to the tables, the four earliest flowers were nine days late, but the effect of May was to make the last four decidedly early. The early migrants were late, especially the nightingale. The 1919 isophenes were seven days further south than in 1918. The number of observers has been further reduced from war effects, barely exceeding 100, but 1920 prospects are such that at least a 100 per cent. increase is probable. The areas worst represented are Wales, the south-west of Ireland, and the north-west of Scotland. Observers from these parts will be most welcome.

MANCHESTER.

Literary and Philosophical Society, April 20.—Sir Henry A. Miers, president, in the chair.—W. J. **Perry**: The origin of warlike States. In previous papers the author has put forward the theory that, speaking generally, warlike States are those with an hereditary military aristocracy. In an examination of the ruling groups of the chief historical peoples, Teutonic, Turko-Tartar, Semitic, the facts suggest their beginning as small groups claiming divine descent. These groups seem to be of "matriarchal" origin, and the chief religious feature was the cult of the Great Mother. Just after the new groups of rulers had been formed, the institutions became patrilineal, and the Great Mother was replaced by gods. Study of the practice of heraldry verifies the author's theory. This law of "dynastic continuity," if true, leads to the conclusion that all ruling classes in the world are derived from one original group; and this result harmonises with Prof. Elliot Smith's claim that all civilisation originated in the Ægypto-Sumerian region.

PARIS.

Academy of Sciences, May 10.—M. Henri Deslandres in the chair.—C. **Guichard**: Networks and congruences conjugated with respect to a linear complex.—Prof. W. H. Perkin was elected a correspondant for the section of chemistry in succession to M. Ciamician, elected foreign associate.—P. **Boutroux**: A family of multiform functions defined by differential equations of the first order.—M. **Janet**: Systems of equations of derived partials.—G. **Cerf**: The analysis of anti-symmetrical tensors and the symbolic forms of differentials.—C. **Camichel**: Application of the principle of images to water-vessels.—Th. **De Donder** and H. **Vanderlinden**: New fundamental equations in generalised co-ordinates.—J. **Carvallo**: A new universal method of measuring and compensating instrumental astigmatism.—A. **Kling** and A. **Lassieur**: The separation of tin and antimony. The estimation of tin by cupferron. The antimony is separated as sulphide in hydrofluoric acid solution, boric acid added to the filtrate to convert the hydrofluoric acid into fluoboric acid, and the tin precipitated by cupferron.—F. **Bourion** and Ch. **Courtois**: A method of modified enrichment in the analysis of commercial chlorobenzenes. Some refinements on a method described in an earlier communication.—G. **Tanret**: Pelletierine and methylpelletierine. Hess and Eichel were unable to isolate the optically active alkaloid pelletierine, and could only obtain the inactive isomer *iso*pelletierine; hence they propose that the name *iso*pelletierine should be dropped. In the present paper experimental confirmation of the work of Ch. Tanret on the optically active alkaloid is given.—A. **Mailhe**: A new preparation of amines by catalysis. The hydrazines obtained from acetaldehyde, *iso*butyraldehyde, and from valeraldehyde heated with hydrogen in presence of nickel give mixtures of primary, secondary, and tertiary amines.—A. **Guébhard**: The planet Mars and "igneous sedimentation."—R. **Souèges**: The embryogeny of the Solanaceæ. Development of the embryo in Nicotiana. Nine diagrams are given showing the principal steps in the development of the embryo. The statement of Hanstein, that the embryo of Nicotiana develops according to laws comparable with those observed in Capsella, is shown to be inexact.—A. **Chevalier**: Researches on the Amygdalaceæ and the apple-trees of the cooler parts of Indo-China and of the south of China.—A. **Piedallu**, P. **Malvezin**, and L. **Grandchamp**: The treatment of the blue *casse* of wines. Oxygen gas in very minute bubbles, produced by forcing the gas under pressure through the walls of a porous porcelain filter, can rapidly convert the ferrous salts into ferric salts. The wines clarify readily, and are reduced to a normal state.—L. **Bertin**: Remarks on the buccal and feeding apparatus in some Coleoptera.—P. **Courmont** and A. **Rochaix**: The action of the microbial flora of sewage effluents purified by the activated-sludge method on carbohydrates.

May 17.—M. Henri Deslandres in the chair.—G. **Bigourdan**: Lechevalier at the Observatory of Saint-Geneviève. The co-ordinates of this observatory.—M. **Hamy**: A particular case of diffraction of the images of circular stars of large diameter.—L. E. Dickson was elected a correspondant for the section of geometry in succession to M. Cosserat, elected non-resident member.—P. **Humbert**: The general solution of the system which satisfies the function W (x, y).—N. **Pipping**: A criterion for real algebraical numbers, based on a direct generalisation of Euclid's algorithm.—J. **Drach**: The spiral compensator and new problems of the mechanics of regulation. The spiral compensator of M. Guillaume, obtained by addition of a third or a fourth metal to an iron-nickel alloy, is the first example of a solid the elasticity of which increases with the temperature. The application of this to the control of chronometer balance-springs is discussed, and reasons are given for supposing that the chronometer will equal the astronomical clock in accuracy.—Ch. **Frémont**: The genesis of cracks in certain axles.—P. **Morin**: The study of flow over a weir with the aid of chronophotography.—M. **Battestini**: The optimum magnification of a telescope. The magnification of a reading telescope should be reduced proportionally to the square root of the illumination of the field.—L. **Thielemans**: Calculations and diagrams of lines carrying energy to great distances.—G. **Bruhat**: The properties of fluids in the neighbourhood of the critical point and the characteristic equations.—J. **Villey**: The discussion of Michelson's experiment.—C. **Zenghelis** and B. **Papaconstantinos**: The acceleration of the decomposition of hydrogen peroxide by colloidal rhodium. From measurements of the velocity constants the reaction is shown to be unimolecular. If the solution of colloidal rhodium is treated with a current of hydrogen or carbon monoxide the reaction is accelerated.—F. **Bourion**: The impurities of the benzene extracted from commercial chlorobenzenes. Normal hexane and heptane have been isolated, and also chloroform, from benzene extracted from commercial chlorobenzene.—C. **Matignon** and Mlle. **Marchal**: The prolonged action of carbon dioxide on silicates and quartz. Six minerals and glass were submitted to the action of a solution of carbon dioxide in water under a pressure of 10 atmospheres for a period of ten years and three months. The quantities of silica in solution were estimated, and the minerals after this exposure examined microscopically for evidence of attack. Quartz, wollastonite, mica, talc, dioptase, and asbestos showed signs of corrosion. With glass the corrosion was scarcely perceptible.—J. **Bougault** and J. **Perrier**: The action of hydrocyanic acid on glucose: Kiliani's reaction. In solutions faintly acid, even as weak as hundredth normal, the combination between hydrocyanic acid and glucose does not take place, and this would also appear to be the case in neutral solution. A slight alkalinity, even as small as that derived from the glass containing vessel, determines the reaction, which is therefore probably between glucose and alkaline cyanide. The reaction between potassium cyanide and glucose was quantitatively studied, and proved to be bimolecular.—L. **Cayeux**: The Hettangian iron minerals of Burgundy. The iron mineral at Beauregard is not oolitic, but the whole of the oxide of iron is a substitution product for calcium carbonate.—Ph. **Négris**: The alternatives of the Glacial and inter-Glacial epochs during the Quaternary period.—G. **Ferronnière**: An Eifel laver of the Basse-Loire synclinal.—A. **Boutaric**: The intensity of nocturnal radiation at high altitudes.—E. **Rothé**: A new electrical anemometer. For observations of wind velocities at high altitudes the anemometer is carried in a small captive balloon, and the anemometer vane serves as an interrupter, which at each contact puts in action a small electrical oscillator. At the base of the cable holding the balloon is a small receiving apparatus for detecting wireless signals. The indications of several instruments fixed at different heights up the cable can be received simultaneously.—G. **André**: The exosmosis of the acid principles and sugars of the orange.—P. **Bugnon**: The structure of certain fibro-vascular bundles in the stems of the Graminaceæ.—H. **Piéron**: The variation of the energy as a function of the time of stimulation for peripheral vision.—A. **Mayer**, H. **Magne**, and L. **Plantefol**: The reflexes provoked by irritation of the respiratory passages. Action of the general exchanges of the organism. The irritation of the terminations of the trigeminal nerve in certain mammals has the effect of causing, for more than half an hour, a reflex diminution of the general exchanges of the organism. These may be lowered to a value very small compared with the normal.—A. **Desgrez** and H. **Bierry**: Nitrogen equilibrium and lack of vitamines.—R. **Hovasse**: The number of chromosomes in parthenogenetic tadpoles.—M. **Delage**: Remarks on the preceding communication.—J. **Legendre**: The food *régime* of *Carassius auratus* in Madagascar.

Books Received.

The Story of a Cuckoo's Egg. By H. Terras. Pp. 95. (London: The Swarthmore Press, Ltd.) 6*s*. net.

A Primer of Air Navigation. By H. E. Wimperis. Pp. xiv+128. (London: Constable and Co., Ltd.) 8*s*. 6*d*. net

The Identification of Organic Compounds. By the late Dr. G. B. Neave and Prof. I. M. Heilbron. Second edition. Pp. viii+88. (London: Constable and Co., Ltd.) 4*s*. 6*d*. net.

The Blind: Their Condition and the Work being done for them in the United States. By Dr. H. Best. Pp. xxviii+763. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 21*s*. net.

Australian Meteorology: A Text-book, including Sections on Aviation and Climatology. By Dr. Griffith Taylor. Pp. xi+312. (Oxford: At the Clarendon Press.) 12*s*. 6*d*. net.

Keys to the Orders of Insects. By F. Balfour-Browne. Pp. vii+58. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Beauty and the Beast: An Essay in Evolutionary Æsthetic. By S. A. McDowall. Pp. vii+93. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Thermodynamics for Engineers. By Sir J. A. Ewing. Pp. xiii+383. (Cambridge: At the University Press.) 30*s*. net.

A Text-book of Physiology. By Prof. R. Burton-Opitz. Pp. 1185. (Philadelphia and London: W. B. Saunders Co.) 32*s*. 6*d*. net.

Intermediate Text-book of Chemistry. By A. Smith. Pp. vi+520. (London: G. Bell and Sons, Ltd.) 8*s*. 6*d*. net.

An Elementary Treatise on Differential Equations and their Applications. By Prof. H. T. H. Piaggio. Pp. xvi+216+xxv. (London: G. Bell and Sons, Ltd.) 12*s*. net.

Problems in Physical Chemistry: With Practical Applications. By Dr. E. B. R. Prideaux. Second edition. Pp. xii+294. (London: Constable and Co., Ltd.) 18*s*. net.

La mort et son mystère: Avant la Mort. By C. Flammarion. Pp. 401. (Paris: E. Flammarion.) 6.50 francs net.

An Introduction to Entomology. By Prof. J. H.

Comstock. Part i. Second edition. Pp. xviii+220. (Ithaca, N.Y.: The Comstock Publishing Co.) 2.50 dollars net.

Plant Indicators: The Relation of Plant Communities to Process and Practice. By F. E. Clements. Pp. xvi+388+92 plates. (Washington: Carnegie Institution of Washington.)

Carnegie Institution of Washington. Year Book No. 18, 1919. Pp. xvi+380+plate. (Washington: Carnegie Institution of Washington.)

Egyptological Researches. Vol. iii. By W. Max Müller. Pp. 88+40 plates. (Washington: Carnegie Institution of Washington.)

Elementary Agricultural Chemistry. By H. Ingle. Third edition. Pp. ix+250. (London: C. Griffin and Co., Ltd.) 5s.

Diary of Societies.

THURSDAY, JUNE 3.

INSTITUTION OF GAS ENGINEERS (at Institution of Mechanical Engineers), at 10 a.m.—Society of British Gas Industries: Carbonisation.—H. J. Hodsman and Prof. J. W. Cobb: Oxygen in Gas Production.—J. Fisher: Electricity Supply by Gas Companies.—G. Warburton: Contemplations on the Report of the Fuel Research Board.

ROYAL HORTICULTURAL SOCIETY (at Royal Gardens, Chelsea), at 3.—Capt. H. J. Page: Green Manuring—Its Possibilities in Horticulture.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—William Archer: Dreams with Special Reference to Psycho-Analysis.

ROYAL SOCIETY, at 4.30.—Sir Ernest Rutherford: The Nuclear Constitution of the Atom (Bakerian Lecture).

LINNEAN SOCIETY OF LONDON, at 5.—R. Swainson-Hall: Exhibition of 50 Drawings of the Oil-Palm, *Elaeis guineensis*.—A. Whitehead: Objects Observed near Basra during the War.—Prof. W. J. Dakin: Whaling in the Southern Ocean.—Dr. R. R. Gates: Demonstration of Chromosomes in the Pollen Development of Lettuce.

CHEMICAL SOCIETY, at 8.—M. O. Forster and W. B. Saville: Studies in the Camphane Series. Part XXXVIII. The Cyanohydrazone of Camphorquinone.—R. G. Fargher: Arsenic Acids derived from Guaiacol and Veratrole.—G. T. Morgan and D. C. Vining: Diphenylarsenious Chloride and Cyanide. (Diphenylchloroarsine and Diphenylcyanoarsine.)—F. Challenger and A. E. Goddard: Organo-derivatives of Bismuth. Part III. The Preparation of Derivatives of Quinquevalent Bismuth.—J. N. Ray: Modification and Extension of Friedel-Crafts' Reaction. Part I.—F. Arnall: The Determination of the Relative Strengths of some Nitrogen Bases of the Aromatic Series and of some Alkaloids.—J. C. Ghosh: The Electrical Conductivity of Pure Salts in the Solid and Fused States; Determination of the Activity Coefficients of Ions in Solid Salts.—W. J. Sanderson and W. J. Jones: Anethole as Solvent in the Cryoscopic Method of Determining Molecular Weight.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. P. Turner: Traumatic Rupture of the Pedicle of a Sub-Peritoneal Fibroid.—Dr. F. Anderson: A Case of Rupture of the Uterus.—Dr. F. Shaw and Dr. Burrowes: Radical Cure of Advanced Carcinoma of the Cervix, made Possible by the Application of Radium.—G. Ley: The Pathology of Accidental Hæmorrhage.

FRIDAY, JUNE 4.

ASSOCIATION OF ECONOMIC BIOLOGISTS AND IMPERIAL ENTOMOLOGICAL CONGRESS.—Joint Meeting (at the Rothamsted Experiment Station), St. Pancras Station 10 a.m. train.

ROYAL SOCIETY OF ARTS (Indian and Colonial Sections, Joint Meeting), at 4.30.—Prof. Sir John Cadman: The Oil Resources of the British Empire.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ronald Ross: Science and Poetry.

SATURDAY, JUNE 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. H. Jeans: The Theory of Quanta.

MONDAY, JUNE 7.

INSTITUTE OF ACTUARIES, at 5.—(Annual General Meeting.)

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—(General Meeting.)

SOCIETY OF CHEMICAL INDUSTRY (at Institute of Chemistry), at 8.—Informal Meeting.)

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—(Election of Council.)

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: Aluminium and its Alloys (Cantor Lecture.)

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Prof. G. A. F. Molengraff: Ocean Research in the Dutch East Indies.

TUESDAY, JUNE 8.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. W. H. Mills and Sir Wm. J. Pope: Studies on Photographic Sensitisers. Part II. (Sensitisers of the Type of Pinacyanol or Sensitol Red.)—G. I. Higson: A Simple Form of Non-intermittent Exposure Machine.—Mr. Offer: Examples of Photographs in Colour taken during Theatrical Performances.—(Lectures under the Control of the Scientific and Technical Group.)

WEDNESDAY, JUNE 9.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. G. Knott: Earthquake Waves and the Elasticity of the Earth.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Institution of Mechanical Engineers), at 6.—M. Latour: High Frequency Machines.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at College of Preceptors), at 6.—W. H. Winch: Equal Additions *versus* Decomposition in Teaching Subtraction: An Experimental Research.

THURSDAY, JUNE 10.

INSTITUTION OF MINING ENGINEERS (at Geological Society), from 11 a.m. to 5.—(General Meeting.)—Prof. H. Louis: Compensation for Subsidence.—W. Maurice: The Fleissner Singing-flame Lamp.—W. Maurice: The Wolf-Pokorny and Wiede Acetylene Safety-lamps.—G. Oldham: The "Oldham" Cap Type Miner's Electric Safety-lamp.—Discussion on First Report of the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines."—D. S. Newey: A New Method of Working Thick Seams of Coal at Baggeridge Colliery.—T. G. Bocking: Protractors.—T. G. Bocking: Magnetic Meridian Observations: A Method of Utilising the Kew Observatory Records.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—A. V. Hill and W. Hartree: The Thermo-Elastic Properties of Muscle.—Sir James Dobbie and J. J. Fox: The Absorption of Light by Elements in the State of Vapour: (1) Selenium and Tellurium; (2) Mercury, Cadmium, Zinc, Phosphorus, Arsenic, Antimony.—H. G. Cannon: Production and Transmission of an Environmental Effect in *Simocephalus vetulus*.—E. C. Grey: The Enzymes of *B. coli communis* which are Concerned in the Decomposition of Glucose and Mannitol. Part IV. The Fermentation of Glucose in the Presence of Formic Acid.—L. T. Hogben: Studies on Synapsis. II. Parallel Conjugation and the Prophase Complex in Periplaneta, with Special Reference to the Premeiotic Telophase.

LONDON MATHEMATICAL SOCIETY, at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. F. Hurst: The Psychology of the Special Senses and their Hysterical Disorders (Croonian Lecture).

OPTICAL SOCIETY, at 7.30.—Miss A. B. Dale: Accuracy of Setting.—Dr. J. S. Anderson: A New Method of Immersion Refractometry.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. C. A. F. Benedicks: The Recent Progress in Thermo-Electricity (Annual May Lecture).

FRIDAY, JUNE 11.

INSTITUTION OF MINING ENGINEERS (at Geological Society), from 11 a.m. to 5.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON, at 5.—Dr. T. Barratt and A. J. Scott: Radiation and Convection from Heated Surfaces.—J. S. G. Thomas: An Electrical Hot-Wire Inclinometer.—L. F. Richardson: Convective Cooling and the Theory of Dimensions.—J. W. T. Walsh: The Radiation from a Perfectly Diffusing Circular Disc.

CONTENTS.

	PAGE
Present State of the Dye Industry	413
Poetry and Medicine. By **Prof. D'Arcy W. Thompson, C.B., F.R.S.**	414
Movements of Plants. By **V. H. B.**	416
Applications of Electricity. By **Dr. A. Russell**	418
British Iron Ores. By **Prof. H. Louis**	419
Our Bookshelf	420
Letters to the Editor:—	
The Flight of Flying-fish.—**Dr. J. McNamara**	421
An Experiment on the Spectrum.—**Dr. R. A. Houstoun**	421
Anti-Gas Fans.—**Mrs. Hertha Ayrton**	422
A New Method for Approximate Evaluation of Definite Integrals between Finite Limits.—**C. F. Merchant**	422
Applied Science and Industrial Research.—**Prof. Frederick Soddy, F.R.S.; Major A. G. Church**	422
The Great Red Spot on Jupiter. (*With Diagram.*)—**W. F. Denning**	423
British and Foreign Scientific Apparatus.—**J. W. Ogilvy; J. S. Dunkerly**	424
Cost of Scientific Publications.—**Dr. C. G. Knott**	425
Natural History Studies in Canada. (*Illustrated.*)	426
Tidal Power. (*With Diagrams.*)	427
Obituary:—	
Prof. C. A. Timiriazeff, For.Mem.R.S.	430
Notes	431
Our Astronomical Column:—	
Return of Tempel's Comet	436
Double Stars	436
Diffraction Image of a Disc	436
Monument to Charles Gerhardt. By **Sir T. E. Thorpe, C.B., F.R.S.**	436
Biological Papers from Bengal	436
Attainment of High Levels in the Atmosphere	437
Physical Problems in Soil Cultivation. By **B. A. Keen**	438
The Anomaly of the Nickel Iron Alloys: Its Causes and its Applications	438
Technical Education and Mind Training	439
University and Educational Intelligence	439
Societies and Academies	441
Books Received	443
Diary of Societies	444